Chapter 2

Theory into Practice

FOUNDATIONS FOR TRANSFORMATIVE TECHNOLOGY INTEGRATION

Learning Outcomes

After reading this chapter and completing the learning activities, you should be able to:

2.1 Identify how the epistemologies of directed instruction and constructivist learning theory foundations and the Turn-Around Technology Integration Pedagogy And Planning (TTIPP) model contribute to transformative technology integration practices. (ISTE Standards for Educators: 1—Learner; 2—Leader; 5—Designer)

2.2 Identify the theorists and beliefs associated with directed instruction learning theories and how these theories contribute to technology integration strategies. (ISTE Standards for Educators: 1—Learner; 5—Designer)

2.3 Identify the theorists and beliefs associated with constructivist instruction learning theories and how these theories contribute to technology integration strategies. (ISTE Standards for Educators: 1—Learner; 5—Designer)

2.4 Contrast directed, constructivist, or combined technology integration strategies. (ISTE Standards for Educators: 1—Learner; 5—Designer)

2.5 Use steps in the Turn-around Technology Integration Pedagogy and Planning (TTIPP) model to determine planning needs for classroom technology integration. (ISTE Standards for Educators: 1—Learner; 2—Leader; 3—Citizen; 4—Collaborator; 5—Designer; 6—Facilitator; 7—Analyst)

Technology Integration in Action: The Role of Learning Theory

Strategy A: Preparing Students for State Tests

One of Mr. Ng's responsibilities as mathematics department chair was helping all teachers make sure their students did well on the mathematics portion of the state's Test of Essential Skills for Success (TESS-M). Mr. Ng and the other math teachers were determined that every student in the school would pass the TESS-M. They also decided that they would not just "teach to the test." They wanted the students to have a good grounding in math skills that would serve them well in their future education.

From practice test scores he had seen, Mr. Ng realized that too many students needed help to provide individual coaches or tutors for each one, and he disliked the idea of making all students work on skills only some of them needed. At a school he had visited in another district, Mr. Ng was impressed with how teachers relied on a computer-based system that included drills, tutorials, simulations, and problem-solving activities that they could access in their classrooms and the computer lab.

One of the benefits of the system was that students could solve math problems and teachers could get a list of skills with which each student was having trouble. Then the system would recommend specific activities, on and off the system, matched to each child's needs. The activities ranged from practice in very basic math skills to solving real-life problems that required algebra and other math skills. Mr. Ng persuaded his principal to purchase a year's subscription to this system, and he and the other math teachers agreed on ways they would use it to support their classroom instruction.

That year, almost every student at the school passed the TESS-M. The math teachers agreed that the computer-based activities had played a key role in students' preparation. They liked the way those activities helped target students' specific needs more efficiently without overemphasizing test taking. Mr. Ng asked the principal to make the system a permanent part of the school's budget.

Strategy B: A Simulated Family Project

Ms. Rodriguez's middle-school math students are usually fairly good at mathematics skills, although based on various practice tests, some would have trouble passing the mathematics portion of state's Test of Essential Skills for Success (TESS-M). Ms. Rodriguez liked to do at least one ongoing project each year to show students how their math skills apply to real-life situations. She also wanted them to learn to work together to solve problems just as they would be doing in high school and college and in work situations when they graduate.

The first activity she implemented at the beginning of each year was to have her students work in small groups to simulate "families." They selected a type of "job" for their "wage earner" and created a monthly budget in a spreadsheet template she designed to show income earned from the imaginary job and estimated monthly expenses for each of them and for the "family." To select jobs, the groups consulted online newspaper Help Wanted sections, websites for job seekers, and adults they knew to get an idea of what positions were available and how much they paid.

To estimate expenses, they researched online newspaper and real estate ads to see how much it cost to rent a house or an apartment in an area where their "family" would live. Throughout the year, she gave each group unexpected expenses (e.g., the dog gets sick, the roof is leaking); the students then adjusted their spreadsheet budget to compensate for the extra expenses. If a group either had a surplus or went into debt, she made the students consider a range of investments, loans, relocating, or selling assets, which they did by researching available interest rates and prices and adding their choices to their spreadsheet budgets.

Toward the end of the year, Ms. Rodriguez had students calculate estimated taxes on their earnings. Finally, they prepared a report using presentation software that showed charts of their spending and what they learned about "making ends meet." The students always told her this was the most meaningful math activity they had ever done.

Introduction

This chapter introduces two essential ingredients of a vision for how technologies work in instruction. These are learning theory foundations and a technology integration planning model. Learning theories have contributed to the use of two instructional strategies—directed and constructivist—that influence teachers' approaches to technology integration.

We take our directed teaching models from learning theorists such as B. F. Skinner, Richard Atkinson and Richard Shiffrin, Robert Gagne, and systems theorists such as Robert Mager, Leslie Briggs, and Lee Cronbach. Our constructivist strategies are based on the work of theorists such as John Dewey, Albert Bandura, Lev Vygotsky, Jean Piaget, Jerome Bruner, and Howard Gardner. You will read about the contributions of these education giants. You'll also read how teachers can use the Turn-around Technology Integration Pedagogy and Planning (TTIPP) model to plan technology integration.

Overview of Successful Technology Integration Planning and Practice

The answer to the question "Which kind of technology integration strategy works best?" is "It depends on the situation." Effective technology integration calls for a well-planned match of learning needs with technology resources. This section introduces how learning theories and a thorough technology integration planning model work in combination to enable transformative technology integration pedagogy.

Learning Theory Foundations

To use all the insights we have gained from the study and research on how people acquire new knowledge, learning theories should inform teaching strategies. Thus, it is important to begin with a look at two very different theories of how learning occurs and examine how various kinds of technology integration strategies can be derived from them.

TWO PERSPECTIVES ON INSTRUCTION Theorists and practitioners reflect two contrasting views of how instruction and learning should take place:

- **Directed instruction**—Teachers should transmit a predefined set of information to students through teacher-organized activities. This view is based on **objectivism**, a belief system grounded primarily in behaviorist learning theory and the information-processing branch of the cognitive learning theories.
- **Constructivist-based instruction**—Teachers should build inquiry, discovery, and experiential learning into their instruction so that learners can generate their own knowledge through experiences while teachers serve as facilitators. This view is based on **constructivism**, which evolved from other branches of thinking in cognitive learning theory.

A few technology applications, such as drill and practice and tutorial software functions, are associated only with directed instruction; most others (problem solving, multimedia production, web-based learning) can be implemented in either directed or constructivist ways, depending on how they are used. There are meaningful roles for both **directed instruction** and **constructivist learning** strategies and the technology applications associated with them. Both can help teachers and students meet the many and varied requirements of learning in today's knowledge society.

ORIGINS OF THESE INSTRUCTIONAL PERSPECTIVES Both people who espouse directed instruction methods and those who use constructivist approaches are attempting to identify what Gagné (1985) called the *conditions of learning*, or sets of circumstances that bring about learning. Both directed instruction and constructivist-based instruction approaches are based on the work of respected learning theorists and psychologists who have studied both the behavior of human beings as learning organisms and the behavior of students in schools and classrooms.

Educators' views diverge, however, in the ways they define learning, how they identify the conditions required to make learning happen, and how they perceive the problems that interfere most with learning. They disagree because the two perspectives have very different underlying **epistemologies**, the beliefs about the nature of human knowledge and how to develop it. **Constructivists and objectivists** come from separate and different **epistemologies**. These philosophical differences can be briefly summarized in the following way:

- **Objectivists**—Knowledge has a separate, real existence of its own outside the human mind. Learning happens when this knowledge is transmitted to people who store it in their minds in ways that they can be retrieve later.
- **Constructivists**—Humans construct all knowledge in their minds by participating in experiences. Learning occurs when someone constructs both mechanisms for learning and that person's own unique version of the knowledge informed by background, experiences, and aptitudes.

Sfard (1998) found that objectivists and constructivists view learning in such different ways that they actually use different metaphors for it: the *acquisition metaphor* and the *participation metaphor*. These differences in language signal fundamental differences in thinking about how learning takes place and how we can foster it.

Sometimes differences of opinion among objectivists and constructivists have generated strident debate in the literature (Clark, Yates, Early, & Moulton, 2009; Baroody, Eiland, Purpura, & Reid, 2013). Objectivists say constructivist methods are unrealistic; constructivists consider directed methods to be too restrictive. The following sections describe learning theories that underlie these belief systems. Subsequent sections discuss how these theories can inform different technology integration strategies.

Turn-around Technology Integration Pedagogy and Planning (TTIPP) Model

For the procedural and "people" issues involved in technology integration, we look to the steps of the three-phased **Turn-around Technology Integration Pedagogy and Planning (TTIPP)** model to plan and implement technology-based lessons. This planning model includes three phases that lead teachers to (1) analyze problems of practice, assess teaching/learning needs/assets, and identify possible technology solutions, (2) design the lesson's objectives, assessments, and instructional and learning strategies; identify the relative advantage; and implement the lesson, and (3) analyze and revise the technology-supported instruction and share outcomes with peer teachers.

The TTIPP model privileges the concept of **turn-around pedagogy** (Kamler & Comber, 2005), which is instruction that revitalizes students' interest and engagement in learning the curriculum. Teachers *turn* toward students by becoming more informed about their background, knowledge, experiences, and interests and by developing asset versus deficit views of the learners. Teachers revitalize their curriculum through new pedagogy that literally *turns* students around from disengagement to re-engagement, which leads to higher achievement.

Another significant feature of the TTIPP model is that it helps teachers evaluate (or **RATify**) their proposed and/or adopted technology-based lessons for their potential to transform teaching, learning, and curriculum using the **Replacement, Amplification, Transformation (RAT)** assessment framework. By RATifying lessons, a teacher will be able to identify exactly how the technology contributes to specific aspects of instruction, learning, and/or curriculum.

The teaching practice and research that originated turn-around pedagogy was accomplished when small groups of teachers inquired into their teaching over a 3-year period (Kamler & Comber, 2005). An individual teacher can implement the TTIPP model alone, but we encourage its use by teachers in collaboration with others, such as media specialists or peer teachers.

Check Your Understanding 2.1

Shared Writing 2.1 Alignment with Directed or Constructivist Strategies

Learning Theory Foundations of Directed Integration Models

Directed models of integrating technology were derived primarily from a combination of four theorists and theories—behaviorist, information-processing, cognitive-behaviorist, and instructional design theories—each of which contributes essential qualities and procedures and the **systems approaches to instructional design** that were based on them. This section summarizes the basic concepts associated with these theories and their implications for education practices and technology integration.

Behaviorist Theories

These theories, among the earliest explanations for how people learn new things, are based primarily on the work of B. F. Skinner (1904–1990). Before Skinner, theories of learning were dominated by **classical conditioning** concepts proposed by Russian physiologist Ivan Pavlov, who proposed that behavior is largely controlled by involuntary physical responses to outside stimuli (e.g., dogs salivating at the sight of a can of dog food). By contrast, Skinner's **operant conditioning** theory asserted that people can have voluntary mental control over their responses (e.g., a child reasons that he will be praised if he behaves well in school). Skinner's work showed that observable behaviors are controlled by the *consequences* of actions rather than by events that precede the actions. A consequence is an outcome (stimulus) after the behavior, which can influence future behaviors. Skinner's work made him a highly influential figure in education.

Skinner reasoned that the internal processes inside the mind involved in learning could not be seen directly. Scientific work had not advanced sufficiently at that time to observe brain activity. Therefore, he concentrated on cause-and-effect relationships that could be established by observation. He found that human behavior could be shaped by **contingencies of reinforcement** or situations in which reinforcement for a learner is contingent on a desired response. He identified three kinds of situations that can shape behavior:

- **Positive reinforcement**—A situation is set up so that an increase in a desired behavior will result from a stimulus. For example, to earn praise or good grades (positive reinforcement), a learner studies hard for a test more often (desired behavior).
- **Negative reinforcement**—A situation is set up so that an increase in a desired behavior will result from avoiding or removing a stimulus. For example, a student dislikes going to detention (negative reinforcement), so to avoid detention again, she is quiet in class more often (desired behavior).
- **Punishment**—A situation is set up so that a decrease in a desired behavior will result from undesirable consequences, such as when a student is given a failing grade (punishment) when he cheats on a test (undesirable behavior), so he is less likely to cheat in the future.

IMPLICATIONS OF BEHAVIORIST THEORIES FOR EDUCATION Skinner's influential book, *The Technology of Teaching* (1968), presented a detailed theory of how classroom instruction should reflect these behaviorist principles. Many of his classroom management and instructional techniques still are widely used today. Skinner believed that teaching is a process of arranging contingencies of reinforcement effectively to bring about learning. He believed that even such high-level capabilities as critical thinking and creativity could be taught in this way; doing so was simply a matter of establishing chains of behavior through principles of reinforcement. Skinner felt that **programmed instruction** was the most efficient means available for learning skills. Educational psychologists such as Benjamin Bloom also used Skinner's principles to develop what became known as mastery learning:

- We know when people learn only by observing changes in their behavior.
- Behavior is shaped by stimulus-response connections.
- Reinforcement strengthens responses; if people do something and are reinforced for it, they learn to respond in predictable ways.
- Chains of behavior become skills.

IMPLICATIONS OF BEHAVIORIST THEORIES FOR TECHNOLOGY INTEGRATION Most original drill and practice software was based on Skinner's reinforcement principles such as when students knew they would receive praise or an entertaining graphic if they gave correct answers. Much tutorial software is based on the idea of programmed instruction. Because the idea behind drill and practice software is to increase the frequency of correct answering in response to stimuli, these packages often are used to help students memorize important basic information whereas tutorial software gives students an efficient path through concepts they want to learn.

Information-Processing Theories

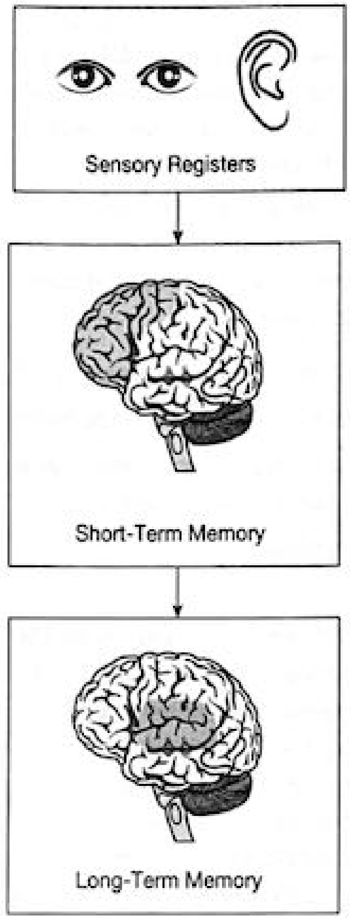
Educators found Skinner's stimulus-response view of learned behavior insufficient to guide all types of learning, so during the 1950s and 1960s, the first cognitive (as opposed to behavioral) learning theorists began to hypothesize about *processes inside the brain* that allow human beings to learn and remember but could not be observed directly.

Although no single, cohesive information-processing theory of learning summarizes the field, the work of the information-processing theorists is based on a model of memory and storage originally proposed by Atkinson and Shiffrin (1968): The brain contains certain structures that process information much like a computer. This model of the mind as computer hypothesizes that the human brain has three kinds of memory or "stores" as represented in Figure 2.1:

- **Sensory registers**—This is the part of memory that receives all the information a person senses.
- **Short-term memory (STM)**—Also known as working memory, this is the part of memory where new information is held temporarily until it is either lost or placed into long-term memory.
- **Long-term memory (LTM)**—This is the part of memory that has an unlimited capacity and can hold information indefinitely.

According to the model of memory and storage, learning begins when information is sensed through receptors: eyes, ears, nose, mouth, and/or hands. This information is held in the sensory registers for a very short time (perhaps a second) after which it either enters STM or is lost. Many information-processing theorists believed that information could be sensed but lost before it gets to STM if the person is not paying attention to it. According to these theorists, anything that people pay attention to goes into working

Figure 2.1 Three kinds of memory



memory where it can stay for about 5 to 20 seconds. After this time, if information is not processed or practiced in a way that causes it to transfer to LTM, then it, too, is lost. Information-processing theorists believed that for new information to be transferred to LTM, it must be linked in some way to prior knowledge already in LTM. Once information does enter LTM, it is there essentially permanently, although some psychologists believed that even information stored in LTM can be lost if not used regularly.

IMPLICATIONS OF INFORMATION-PROCESSING THEORIES FOR EDUCATION Although subsequent studies have indicated that learning could be more complicated than this model of memory would explain (Schunk, 2012), information-processing views have become the basis for many common classroom practices. Teaching practices based on these concepts include the use of:

1. Interesting questions and eye-catching material to help students pay attention to a new topic, such as a photographs or graphs
2. Mnemonic devices, such as remembering that HOMES stands for the first letters of the five Great Lakes: Huron, Ontario, Michigan, Erie, Superior
3. Instructions that point out (or cue) important points in new material to help students remember, such as linking them to information they already know
4. Visual explanations of abstract concepts, such as from virtual manipulatives or simulations
5. Practice exercises to help transfer information from STM to LTM, such as drill and practice or tutorials

IMPLICATIONS OF INFORMATION-PROCESSING THEORIES FOR TECHNOLOGY INTEGRATION Computer programs provide ideal environments for the highly structured cueing, attention-getting, visualization, and practice features that information-processing theorists found so essential to learning and remembering. Information-processing theories have also guided the development of **artificial intelligence (AI)** applications, an attempt to develop computer software that can simulate the thinking and learning behaviors of humans. Much of the drill and practice functions within learning software available is designed to help students encode and store newly learned information into LTM.

Cognitive-Behaviorist Theory

Robert Gagné (1916–2002) was a renowned educational psychologist who translated principles from behaviorist and information-processing theories into practical instructional strategies that teachers could employ with directed instruction. He is best known for three of his contributions in this area: Events of Instruction, types of learning, and learning hierarchies. Gagné used the information-processing model of internal processes to derive a set of guidelines that teachers could follow to arrange optimal "conditions of learning." His set of **Nine Events of Instruction** was perhaps the best known of these guidelines (Gagné, Briggs, & Wager, 1992):

1. Gaining attention
2. Informing the learner of the objective
3. Stimulating recall of prerequisite learning
4. Presenting new material
5. Providing learning guidance
6. Eliciting performance
7. Providing feedback about correctness
8. Assessing performance
9. Enhancing retention and recall

Gagné identified several types of learning as behaviors that students demonstrate after acquiring knowledge. These differ according to the conditions necessary to foster them. He showed how the Events of Instruction would be carried out slightly differently for the five domains of learning outcomes (Gagné et al., 1992):

1. Intellectual skills:
   - Problem solving
   - Higher order rules
   - Defined concepts
   - Concrete concepts
   - Discriminations
2. Cognitive strategies
3. Verbal information
4. Motor skills
5. Attitudes

The development of "intellectual skills," Gagné believed, requires learning that is akin to a building process. Lower level skills provide a necessary foundation for higher level ones. For example, to learn to solve long division problems, students first would have to learn all the prerequisite math skills, beginning with number recognition, number facts, simple addition and subtraction, multiplication, and simple division. Therefore, to teach a skill, a teacher must first identify its prerequisite skills and make sure students possess them. He called this list of building block skills a **learning hierarchy**.

IMPLICATIONS OF COGNITIVE-BEHAVIORIST THEORY FOR EDUCATION Instruction based on this theory provides "conditions for learning" by offering activities matched to each type of skill. Students had to demonstrate that they had learned prerequisite skills by demonstrating the type of behavior appropriate for the skill. For example, if the skill was using a grammar rule, students had to demonstrate that they could correctly apply the rule in situations that required it. Gagné's Events of Instruction and learning hierarchies have been widely used to develop systematic instructional design principles. Although his work has had more impact on designing instruction for business, industry, and the military than for K–12 schools, many school curriculum development projects still use a learning hierarchy approach to sequencing skills.

IMPLICATIONS OF COGNITIVE-BEHAVIORIST THEORY FOR TECHNOLOGY INTEGRATION Computer-based methods such as drills and tutorials were deemed useful because they could consistently provide the ideal events and conditions for learning. Gagné, Wager, and Rojas (1981) showed how Gagné's Events of Instruction could be used to plan lessons using each kind of instructional software function (drill, tutorial, simulation). These authors said that only a tutorial could "stand by itself" and accomplish all of the necessary events of instruction; the other kinds of software required teacher-led activities to accomplish events before and after software use.

Systems Approaches: Instructional Design Models

There are many versions of the systematic design process and many views on what constitutes instructional design (Roblyer, 2015). Saettler (1990) proposed that instructional systems developed scientifically precede the 21st century but pointed out that modern instructional design models and methods have their roots in the collaborative work of Robert Gagné and Leslie Briggs. These notable educational psychologists developed a way to transfer "laboratory-based learning principles" gleaned from military and industrial training to create an efficient way to develop curriculum and instruction for schools.

Gagné specialized in the use of instructional task analysis to identify required subskills and conditions of learning for them. Briggs' expertise was in systematic methods of designing training programs to save companies time and money in training their personnel. When Gagné and Briggs combined their two areas of expertise, the result was a set of step-by-step processes known as a **systems approach to instructional design** or systematic instructional design, which came into common use in the 1970s and 1980s. Designers created an instructional system by stating goals and objectives; analyzing a task to decide on learning conditions; aligning assessment and instructional strategies with goals and objectives; creating materials that deliver strategies; and testing and revising materials before finalizing them.

Theorists and ideas associated with the development of instructional design process include Mager (instructional objectives), Glaser (criterion-referenced testing), and Cronbach and Scriven (formative and summative evaluation). Other major contributors to modern instructional design models include Merrill (component display theory) and Reigeluth (elaboration theory).

IMPLICATIONS OF SYSTEMS APPROACHES FOR EDUCATION Systems approaches to designing instruction have had great influence on training programs for business, industry, and the military but somewhat less on K–12 education. However, performance objectives and sequences for instructional activities still are widely used. Most lesson planning models call for performance objectives (sometimes called behavioral objectives) to be stated in terms of measurable, observable learner behaviors.

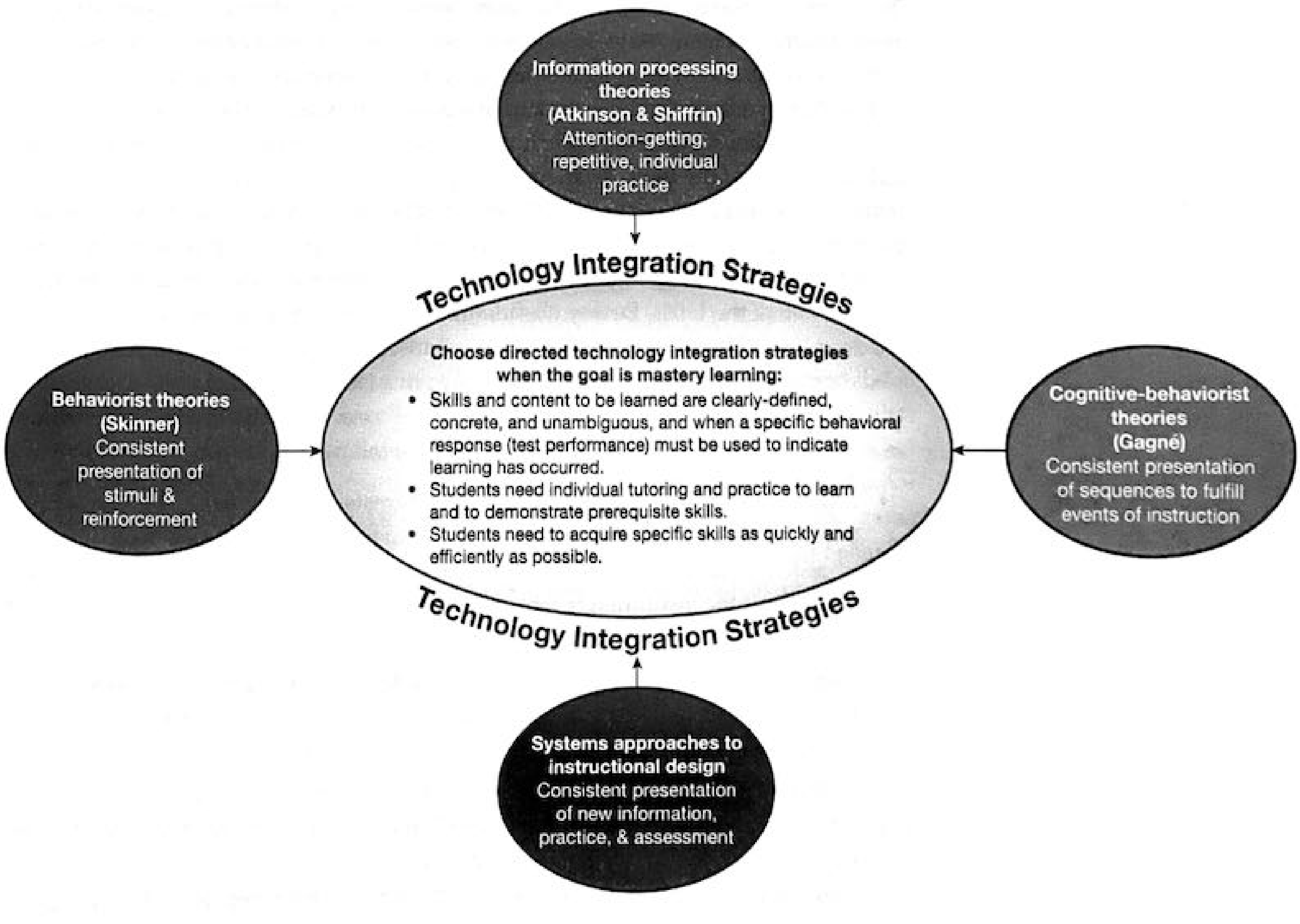
IMPLICATIONS OF SYSTEMS APPROACHES FOR TECHNOLOGY INTEGRATION Most directed models for using technology resources are based on systems approaches; that is, teachers set objectives for a lesson and then develop a sequence of activities. A software package or a web activity is selected to carry out part of the instructional sequence. For example, the teacher could introduce a principle of genetics and then allow students to experiment with an online simulation to "breed" cats to see the principle in action. To those who espouse this approach, a system of instruction must be structured and sequential and continually monitor student progress. Computer-based instruction is well suited to delivering such an instructional system in a consistent and reliable way while monitoring and giving fast feedback on student progress.

Objectivist Theory Foundations for Directed Methods

Figure 2.2 shows how these four theories contribute to directed technology integration strategies based on mastery learning approaches, or sequences of objectives that, once met, define mastery of a subject. A considerable body of research indicates that directed methods work well to foster this kind of approach. For example, Clark, Yates, Early, and Moulton (2010) argue that directed instruction is more effective and efficient than minimally guided instruction when learners do not have enough prior knowledge to be self-guided. They say that minimally guided instruction ignores the fundamentals of human cognition and overloads working memory. Adams, Mayer, MacNamara, Koenig, and Wainess (2012) and other scholars have echoed Hirsch's (2002) early declaration that "one minute of explicit (directed) learning can be more effective than a month of implicit (exploratory) learning."

Objectivists focus primarily on technology integration strategies for systematically designed, structured learning products, such as drills, tutorials, and adaptive or personalized learning systems. When they do use other materials such as simulations and some kinds of problem-solving software that have no innate structure, integration

Figure 2.2 Theoretical Foundations for Directed Technology Integration Strategies



strategies are very structured, providing a step-by-step sequence of learning activities matched to specific performance objectives. When objectivists evaluate these products, they typically look for a match among objectives, methods, and assessment strategies and how well they help teachers and students meet curriculum standards. To reflect objectivist principles, materials and integration strategies must have clearly defined objectives and a set sequence for their use.

Check Your Understanding 2.2

Learning Theory Foundations of Constructivist Integration Models

Constructivist beliefs and methods were derived from a combination of six theorists and theories, each of which contributed essential qualities and procedures: social activism theory, social cognitive theory, scaffolding theory, child development theory, discovery learning and child development, and multiple intelligences theory. This section summarizes the basic concepts associated with each of these theories and their implications for education practices and for technology integration.

Social Activism Theory

John Dewey (1859-1952) is considered a philosopher and an educational writer. Most of his contributions to education predated those of the learning theorists described previously. Yet no one voice in education has had more pervasive and continuing influence on educational practice. In many ways, he can be thought of as the Grandfather of Constructivism, but he also advocated merging absolutism and experimentalism in much the same way as this chapter acknowledges using a combination of directed and constructivist methods.

Dewey's beliefs were very much shaped by his direct involvement in the social and cultural issues of the time. As an early proponent of racial equality and women's suffrage, he was a radical in his political views and helped found a third American political party for liberals. His beliefs about education reflected this radical activism. Although he did not originate the Progressive Education Movement, a reform initiative popular in the first half of the 1900s, Dewey was identified closely with it; the movement survived his death in 1952 by only a few years. His philosophy of education, which he was able to see implemented at the turn of the century in a laboratory school established at the University of Chicago, focused on principles and concepts in direct opposition to those in education during that period. He believed the following:

- **Curricula should arise from students' interests**—Dewey deplored standardization. He felt curriculum should be flexible and tailored to the needs of each student, a "pedocentric" strategy where the children are central rather than the "scholiocentric" where the institution is central. He advocated letting each child's experiences determine individual learning activities.
- **Curricula topics should be integrated rather than isolated from each other**—Dewey felt that isolating topics from one another prevented learners from grasping the whole of knowledge and caused skills and facts to be viewed as unrelated bits of information.
- **Education is growth rather than an end in itself**—Dewey did not share the common view of the time that education is preparation for work. He found that this view served to separate society into social classes and promote elitism. Rather, he

looked on education as a way of helping individuals understand their culture and develop their relationship to society and their unique roles in it.

- **Education occurs through its connection with life rather than through participation in curriculum**—Dewey felt that social consciousness was the ultimate aim of all education. To be useful, all learning had to be in the context of social experience. However, he found that school skills such as reading and mathematics were becoming ends in themselves, disconnected from any meaningful social context.
- **Learning should be hands on and experience based rather than abstract**—Dewey objected to commonly used teaching methods characterized by teacher-to-student communication channels and prioritized memorization and recall. He believed that meaningful learning resulted from students working cooperatively on tasks that were directly related to their interests. Dewey's writings (e.g., *The School and Society*, 1899; *The Child and the Curriculum*, 1902; *How We Think*, 1910; *Schools of Tomorrow*, 1915; *Democracy and Education*, 1916; *Experience and Education*, 1938) spanned an era of monumental change in America's cultural identity and helped reform the country's education system to reflect those changing times.

IMPLICATIONS OF SOCIAL ACTIVISM FOR EDUCATION Today's interdisciplinary curriculum and hands-on, experience-based learning are very much in tune with Dewey's lifelong message. However, it also is likely that he would deplore the current standards movement and the use of testing programs to determine school promotion and readiness for graduation.

IMPLICATIONS OF SOCIAL ACTIVISM FOR TECHNOLOGY INTEGRATION Dewey would likely have approved of technologies such as use of the web to help students communicate with each other and learn more about their society (Bruce, 2000). Dewey's emphasis on the need for cooperative learning would mesh well with technologies used for developing group projects and presentations. However, as Dewey himself recognized, the central problem with all these resources is combining them into a curriculum that encourages intellectual challenge.

Social Cognitive Theory

The work of Albert Bandura (1925–) challenged some of the major premises of conditioning theories that were most popular at that time. He said that contrary to the behavioral theories of reinforcement, students learned a great deal through observation (which he called **vicarious learning**) rather than through their actions (which he called **enactive learning**) (Schunk, 2012). Bandura found, for example, that one of the most powerful ways students learned was by observing the behaviors modeled by those around them.

Bandura also found there was a difference between learning and behaviors that showed learning. Learning was acquiring new information or concepts, but he found that students often learned information and concepts in social settings that they did not reflect in any immediate behavior. Although he acknowledged that enactive learning was learning from one's own actions, his ideas differed from Skinner's view that behavior changed automatically (i.e., without intention) as a result of reinforcement. Instead, Bandura found that students' beliefs and judgments as social beings determined whether or not their actions changed; their internal cognitive processes shaped their actions rather than being solely a result of external consequences resulting from reinforcement.

Motivation to learn also played a central role in Bandura's social cognitive theory. He found that students who were innately capable sometimes did not learn because they lacked **self-efficacy**, or the belief in their abilities to accomplish the actions necessary to learn. Self-efficacy beliefs can be shaped by teachers and others and can affect whether students even try to learn as well as how long they persist at learning tasks. Schunk (2012) reported a series of studies showing that students' self-efficacy and achievement increased from watching videos of their own or peers' performance. Self-efficacy differs from self-concept in that self-concept is a general self-perception of one's overall abilities; self-efficacy is a belief specific to a certain area of learning.

IMPLICATIONS OF SOCIAL COGNITIVE THEORY FOR EDUCATION Educators' practices acknowledge the importance of modeling. They frequently try to shape student behaviors and grow motivation to learn by showing other students of similar age and backgrounds exhibiting these behaviors. Teachers also provide models, though sometimes inadvertently. Students tend to imitate what teachers do rather than attending to what teachers say.

IMPLICATIONS OF SOCIAL COGNITIVE THEORY FOR TECHNOLOGY INTEGRATION Video examples can provide many examples of models that teachers would not otherwise have at their disposal. In addition, studies have shown that self-modeling videos in which students watch examples of their own successful performance can increase their self-efficacy in the area.

Scaffolding Theories

Lev Semenovich Vygotsky (1896–1934) was a Russian philosopher and educational psychologist whose ideas had more influence on the development of educational theory and practice in America than in his own country (Davydov, 1995). Vygotsky felt that cognitive development was directly related to and based on social development (Eggen & Kauchak, 2016). What children learn and how they think are derived directly from the culture around them. Children learn by **scaffolding**, or building what they need to know on what they know with the help of adults. An adult perceives things much differently than a child does, but this difference decreases as children gradually translate their social views into personal, psychological ones. Vygotsky's theories with their emphasis on individual differences, personal creativity, and the influence of culture on learning were discordant with the socialist state of the USSR.

Vygotsky referred to the difference between these two levels of cognitive functioning (adult/expert and child/novice) as the **zone of proximal development (ZPD)**. He felt that teachers could provide good instruction by finding out where each child was in his or her development and building on the child's experiences. He called this building process "scaffolding." Ormrod (2014) stated that teachers promote students' cognitive development by presenting some classroom tasks that "they can complete only with assistance, that is, within each student's zone of proximal development" (p. 39). Problems occur when the teacher leaves too much for the child to do independently, thus slowing the child's intellectual growth.

IMPLICATIONS OF SCAFFOLDING THEORIES FOR EDUCATION Davydov (1995) found six basic implications for education from Vygotsky's ideas (p. 13):

1. Education is intended to develop children's personalities.
2. The human personality is linked to its creative potential, and education should be designed to discover and develop this potential to its fullest in each individual.
3. Teaching and learning assume that students master their inner values through some personal activity.
4. Teachers direct and guide the individual activities of the students, but they do not force their will on them or dictate to them.
5. The most valuable methods for student learning are those that correspond to their individual developmental stages and needs; therefore, these methods cannot be uniform across students.
6. These ideas had heavy influence on constructivist thought; Vygotsky's works were very much in tune with constructivist concepts of instruction based on each child's personal experiences and learning through collaborative, social activities.

IMPLICATIONS OF SCAFFOLDING THEORIES FOR TECHNOLOGY INTEGRATION
Many constructivist models of technology use the concepts of scaffolding and developing each individual's potential. Many of the more visual tools, from Logo, a programming language designed to let young students solve design problems with an on-screen cursor or small robot called a "turtle," to virtual reality, are used under the assumption that they can help bring the student up from their level of understanding to a higher level by showing graphic examples and by giving them real-life experiences relevant to their individual needs.

Child Development Theory

French biologist Jean Piaget (1896–1980) explored early stages of development in children and the role of environment in these stages. Piaget's examination of how thinking and reasoning abilities develop in the human mind began with observations of his own children and developed into a career that spanned some 60 years. He referred to himself as a "genetic epistemologist," or a scientist who studies how knowledge begins and develops in individuals. Both believers in and critics of Piagetian principles agree that his work was complex, profound, sometimes misunderstood, and usually oversimplified. However, at least two features of this work are widely recognized as underlying all of Piaget's theories: his stages of cognitive development and his processes of cognitive functioning.

Piaget believed that all children go through four stages of cognitive development. Whereas the ages at which they experience these stages vary somewhat, he felt that each child developed higher reasoning abilities in the same sequence:

- **Sensorimotor stage** (from birth to about 2 years)—Children explore the world around them through their senses and through motor activity. In the earliest stage, they cannot differentiate between themselves and their environments (if they cannot see something, it does not exist). Also, they begin to have some perception of cause and effect; they develop the ability to follow something with their eyes.
- **Preoperational stage** (from about age 2 to about age 7)—Children develop greater abilities to communicate through speech and to engage in symbolic activities such as drawing objects and playing by pretending and imagining; develop numerical abilities such as the skill of assigning a number to each object in a group as it is counted; increase their level of self-control and are able to delay gratification but are still fairly egocentric; and are unable to do what Piaget called conservation tasks (tasks that call for recognizing that a substance remains the same even though its appearance changes; e.g., shape is not related to quantity).
- **Concrete operational stage** (from about age 7 to about age 11)—Children increase in abstract reasoning ability and ability to generalize from concrete experiences and can do conservation tasks.
- **Formal operations stage** (from about age 12 to about age 15)—Children can form and test hypotheses, organize information, and reason scientifically; they can show results of abstract thinking in the form of symbolic materials (e.g., writing, drama).

Piaget believed a child's development from one stage to another was a gradual process of interacting with the environment. Children develop as they confront new and unfamiliar features of their environment that do not fit with their current views of the world. When this happens, a **disequilibrium** occurs that the child seeks to resolve through one of two processes of adaptation. The child either fits the new experiences into his or her existing view of the world (a process called **assimilation**) or changes that schema or view of the world to incorporate the new experiences (a process called **accommodation**). Although recent research has raised questions about the ages at which children's abilities develop and it is widely believed that age does not determine development alone, Ormrod (2014) summarizes Piaget's basic assumptions about children's cognitive development in the following way:

- Children are active and motivated learners.
- Children's knowledge of the world becomes more integrated and organized over time.
- Cognitive development depends on interaction with one's physical and social environment.
- The processes of equilibration (resolving disequilibrium) help to develop increasingly complex levels of thought.
- Children learn through the processes of assimilation and accommodation.
- Cognitive development can occur only after certain genetically controlled neurological changes occur.
- Cognitive development occurs in four qualitatively different stages.

IMPLICATIONS OF CHILD DEVELOPMENT THEORY FOR EDUCATION One frequently expressed instructional principle based on Piaget's stages is the need for concrete examples and experiences when teaching abstract concepts to young children who may not yet have reached a formal operations stage. Piaget himself repeatedly expressed a lack of interest in how his work applied to school-based education, calling it "the American question," but today's early childhood and elementary curricula reflect many of Piaget's beliefs about children's developmental levels. Piaget pointed out that much learning occurs without any formal instruction as a result of the child's interacting with the environment. However, constructivist educators tend to claim Piaget as the philosophical mentor who guides their work.

IMPLICATIONS OF CHILD DEVELOPMENT THEORY FOR TECHNOLOGY INTEGRATION Piaget's pupil, mathematician Seymour Papert (1928–2016) of the Massachusetts Institute of Technology, used Piaget's theories as the basis of his work with Logo. This environment provided the vital link that Papert felt would allow children to move more easily from the concrete operations or earlier stages of development to more abstract (formal) operations. Papert's 1980 book, *Mindstorms*, challenged then-current instructional goals and methods for mathematics and became the first constructivist statement of educational practice with technology.

Many technology-using teachers feel that using visual resources such as Logo and simulations can help raise children's developmental levels more quickly than would have occurred through maturation. Thus, children who use these resources can learn higher level concepts that they normally would not have been able to understand until they were older. Other educators feel that young children should experience things in the "real world" before seeing them represented in the more abstract ways they are shown in software, for example, in computer simulations.

Discovery Learning

Educational theorist Jerome Bruner (1915–2016) was interested in children's stages of cognitive development and believed that children go through three stages of intellectual development (Schunk, 2012):

- **Enactive stage** (from birth to about age 3)—Children perceive the environment solely through actions that they initiate. They describe and explain objects strictly in terms of what they can do with them. The child cannot tell how a bicycle works but can show what to do with it. Showing and modeling have more learning value than telling for children at this stage.
- **Iconic stage** (from about age 3 to about age 8)—Children can remember and use information through imagery (mental pictures or icons). Visual memory increases

and children can imagine or think about actions without actually experiencing them. Decisions are still made on the basis of perceptions rather than language.

- **Symbolic stage** (from about age 8)—Children begin to use symbols (words or drawn pictures) to represent people, activities, and things. They have the ability to think and talk about things in abstract terms. They can also use and understand what Gagné would call "defined concepts." For example, they can discuss the concept of toys and identify various kinds of toys rather than defining them only in terms of toys they have seen or handled. They can better understand mathematical principles and use symbolic idioms such as "Don't cry over spilt milk."

IMPLICATIONS OF DISCOVERY LEARNING FOR EDUCATION Bruner was very concerned that school instruction builds on the stages of cognitive development. Bruner's theories are associated with unstructured learning activities that he called **discovery learning**. Discovery learning is "an approach to instruction in which students construct their own knowledge about a topic through firsthand interaction with an aspect of their environment" (Ormrod, 2014, p. G-4). They do this "by randomly exploring and manipulating objects or perhaps by performing systematic experiments" (Ormrod, 2014, p. 405). Bruner felt that students were more likely to understand and remember concepts they had discovered in the course of their own exploration. However, research findings have yielded mixed results for discovery learning, and the relatively unstructured methods recommended by Bruner have not found widespread support (Eggen & Kauchak, 2013; Ormrod, 2014). Teachers have found that discovery learning is most successful when students have prerequisite knowledge and undergo some structured experiences.

IMPLICATIONS OF DISCOVERY LEARNING FOR TECHNOLOGY INTEGRATION Many of the more "radical constructivist" uses of technology employ a discovery learning approach suggested by Bruner. For example, rather than telling students how logic circuits work, a teacher might allow students to use a simulation that lets them discover the rules themselves. Most school uses of technology, however, are what Eggen and Kauchak (2016) call a guided discovery learning approach. For example, a teacher may introduce a video-based problem scenario and then help students develop their approaches to solving the problem.

Multiple Intelligences Theory

Of all the learning and developmental theories embraced by constructivists, Howard Gardner's (1943–) is the only one that attempted to define the role of intelligence in learning. Gardner's **multiple intelligences theory** is based on Guilford's pioneering work on the structure of intellect (Eggen & Kauchak, 2016) and Sternberg's view of intelligence as influenced by culture (Ormrod, 2014). Gardner's theory (1983) posits that at least eight different and relatively independent types of intelligence exist, summarized in Table 2.1.

IMPLICATIONS OF MULTIPLE INTELLIGENCES THEORY FOR EDUCATION If Gardner's theory is correct, IQ tests (which tend to stress linguistic and logical-mathematical abilities) may not be a comprehensive or accurate way to judge a student's ability to learn, and traditional academic tasks may not be the best reflection of ability. McDevitt and Ormrod (2010) also warn that if intelligence is culture dependent or culturally sensitive, children from different cultures will have different forms of intelligent behavior. Teachers, then, should try to determine which type or types of intelligence each student has and direct the student to learning activities that capitalize on these innate abilities. Also, teachers should consider learning activities based on distributed intelligence when each student makes a different but valued contribution to creating a product or solving a problem.

Table 2.1 Eight Types of Intelligences

Type of Intelligence	Description	Reflected in Types of Professions or People
Linguistic	• Uses language effectively • Is sensitive to the uses of language • Writes clearly and persuasively	Writer, journalist, poet
Musical	• Understands musical structure and composition • Communicates by writing or playing music	Composer, pianist, conductor
Logical-mathematical	• Reasons logically in math terms • Recognizes patterns in phenomena • Formulates and tests hypotheses and solves problems in math and science	Scientist, mathematician, doctor
Spatial	• Perceives the world in visual terms • Notices and remembers visual details • Can recreate things after seeing them	Artist, sculptor, graphic artist
Bodily kinesthetic	• Uses the body skillfully • Manipulates things well with hands • Uses tools skillfully	Dancer, athlete, watchmaker
Intrapersonal	• Is an introspective thinker • Is aware of one's own motives • Has heightened metacognitive abilities	Self-aware/self-motivated person
Interpersonal	• Notices moods and changes in others • Can identify motives in others' behavior • Relates well with others	Psychologist, therapist, salesperson
Naturalist	• Can discriminate among living things	Botanist, biologist

IMPLICATIONS OF MULTIPLE INTELLIGENCES THEORY FOR TECHNOLOGY INTEGRATION Gardner's theory meshes well with the trend toward using technology to support group work. When educators assign students to groups to develop a multimedia product, they can assign roles to students based on their type of intelligence. For example, a group of students conducting a research project might distribute responsibilities with those with high interpersonal intelligence could be the project coordinators, those with high logical–mathematical ability can be responsible for data analysis and charts, and those with spatial ability can be responsible for presentation aesthetics.

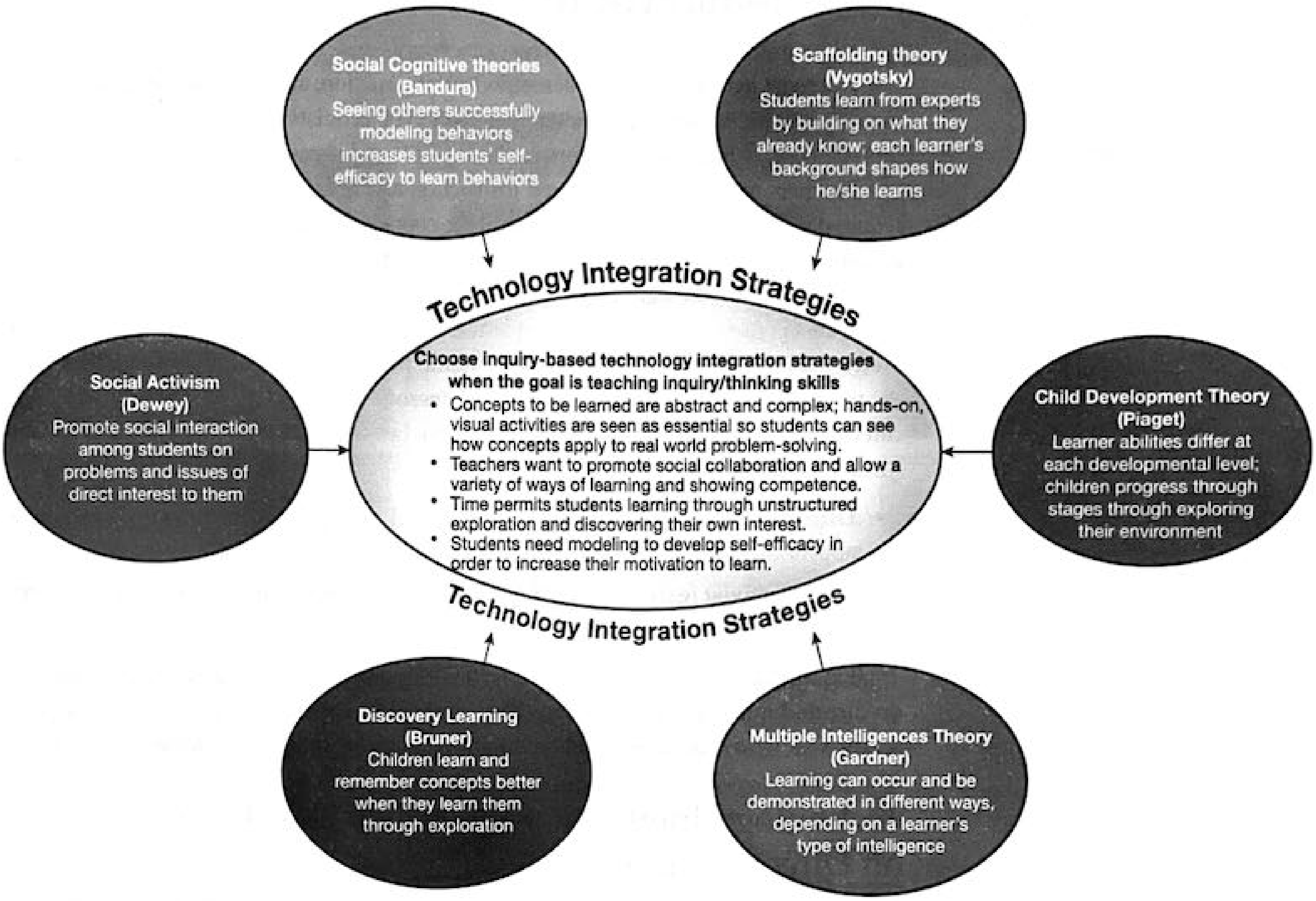
Social Constructivist Theory Foundations for Technology Integration Methods

Figure 2.3 shows how these six theories contribute to strategies for constructivist technology integration.

These theories were designed to address a problem that John Seely Brown (1940–) called **inert knowledge**, a term introduced by Whitehead in 1929 to mean skills that students learned but did not know how to transfer later to problems that required their application (Brown, Collins, & Duguid, 1989). Brown said that inert knowledge resulted from learning skills in isolation from each other and from real-life application; thus, he advocated cognitive apprenticeships, or activities that called for authentic problem solving, that is, solving problems in settings that are familiar and meaningful to students (Cognition and Technology Group at Vanderbilt, 1990). These ideas were based on the theories of Dewey, Bandura, Vygotsky, Piaget, and Bruner.

Today's technology-enabled environments are designed to provide learning environments that reflect **situated cognition**, or instruction anchored in experiences that learners considered authentic because they emulate the behavior of experts in the disciplines. These kinds of materials were intended to assist teachers in helping students build on or "scaffold" from experiences they already had to generate their own knowledge in an active, hands-on way rather than receiving it passively. Today's constructivist integration strategies often focus on having students use data-gathering tools (e.g., mobile

Figure 2.3 Theoretical Foundations for Constructivist Technology Integration Strategies



technologies) to study problems and issues in their locale, on creating multimedia products to present their new knowledge and insights, on immersing themselves in simulated inquiry-based environments, and on communicating with others around the globe.

Application Exercise 2.1 Key Terms for Directed from Constructivist Theories

✓ **Check Your Understanding** 2.3

Technology Integration Strategies Based on Directed and Constructivist Theories

Objectivists and constructivists view learning and the kinds of problems (or different aspects of the same problems) confronting teachers and students in today's schools differently. This section compares common approaches with instruction and assessment and technology integration strategies that reflect each theoretical approach.

Instruction and Assessment in Directed and Constructivist Theories

Table 2.2 summarizes and compares how objectivists and constructivists view directed and constructivist instructional needs, methods of instruction, and assessment strategies differently. Instructional problems identified by both objectivists and constructivists are common in most schools and classrooms regardless of grade level, type of student, or content.

Teachers may use some directed instruction as the most efficient means of teaching required skills while implementing motivating, cooperative learning activities to ensure that students want to learn and that they can transfer what they learn to problems they encounter.

Teachers may design and implement directed and/or constructivist instruction based on (1) their own view of knowledge and learning, (2) the dominant theoretical views within their school, or (3) views built into premade curriculum or other materials. As teachers design technology-supported lessons, they must consider the tenets of directed instruction and constructivist approaches to select technology resources and integration methods that are best suited to their specific needs. In summary,

- **Directed instruction** could be best for providing a foundation of skills. Systematic approaches ensure that specific prerequisite skills are learned.
- **Constructivist learning** may be best for developing the ability to build and apply experience-based knowledge to unique problems.

Figure 2.4 shows examples of four technology integration strategies based primarily on directed models, four based on constructivist models, and four strategies used to address either model. These will be described in more detail in the following sections.

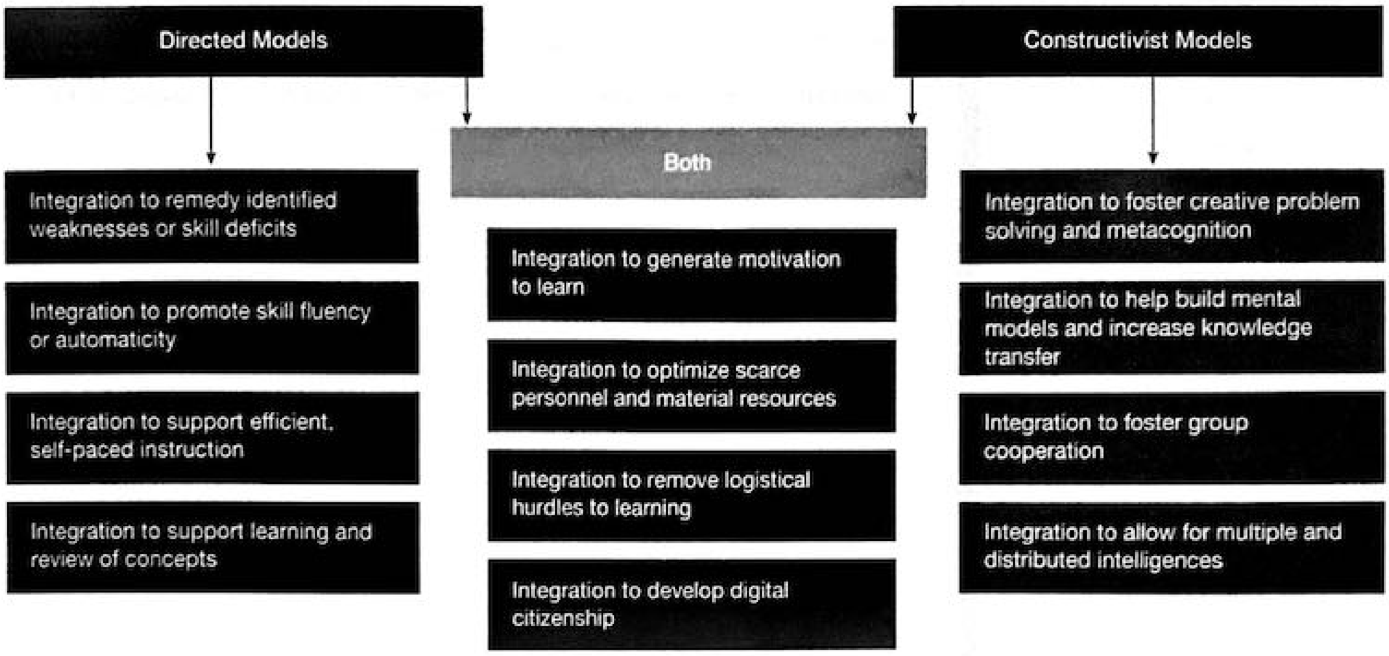
Technology Integration Strategies Based on Directed Models

The four integration strategies based on directed methods primarily address individual instruction and practice (see Table 2.3).

Table 2.2 Directed and Constructivist Instructional Needs, Methods, and Assessment

Directed Instructional Models	Constructivist Models
Instructional Needs	
• *Accountability*: All students must meet required education standards to be considered educated. • *Individualization*: This helps meet individual needs of students working at many levels. • *Quality assurance*: The quality of instruction must be consistently high across teachers and schools in various locations. • *Convergent thinking*: All students must have the same skills.	• *Higher-level skills*: All students must be able to think critically and creatively and solve problems. • *Cooperative group skills*: This helps students learn to work with others to solve problems. • *Increase relevancy*: Students must have active, visual, authentic learning experiences that relate to their own lives. • *Divergent thinking*: Students must think on their own and solve novel problems as they occur.
Methods of Instruction	
• Stress individualized work. • Have specific skill-based instructional goals and objectives that are the same for all students. • Transmit a set body of skills and/or knowledge to students. • Have students learn prerequisite skills required for each new skill. • Provide sequences of carefully structured presentations and activities to help students understand (process), remember (encode and store), and transfer (retrieve) information and skills. • Use teacher-directed methods and materials: lectures, skill worksheets.	• Stress group-based, cooperative work. • Have global goals such as problem solving and critical thinking that sometimes differ for each student. • Have students generate their own knowledge through experiences anchored in real-life situations. • Have students learn lower-order skills in the context of higher-order problems that require them. • Provide learning through problem-oriented activities (e.g., "what if" situations); visual formats and mental models; rich, complex, learning environments; and exploration. • Use materials to promote student-driven exploration and problem solving.
Assessment Strategies	
• Assessments (e.g., multiple choice, short answer) emphasize knowledge recall with specific expected responses; student products (e.g., essays) are graded with checklists or rubrics.	• Assessments (e.g., group products such as web pages, multimedia projects) emphasize application of knowledge with varying contents or portfolios; student products are graded with self-report instruments, rubrics.

Figure 2.4 Technology Integration Strategies for Directed, Constructivist, or Both Models



INTEGRATION STRATEGIES BASED ON DIRECTED MODELS TO REMEDY IDENTIFIED WEAKNESSES OR SKILL DEFICITS Students need to learn prerequisite skills required to advance their knowledge in deeper ways. However, experienced teachers know that even motivated students do not always learn skills as expected. These challenges occur for a variety of reasons, some related to learners' internal capabilities, to teachers' instruction, or to the topic and materials. When the absence of prerequisite skills presents a barrier to higher-level learning or to passing tests, directed instruction may be the most efficient way of providing these skills. In addition to human interventions such as tutoring, materials such as drill and practice and tutorial software have proven to be valuable resources for providing this kind of individualized instruction. Some students who need more instruction to learn required skills may find technology-based materials more motivating and less threatening than teacher-delivered instruction.

INTEGRATION STRATEGIES BASED ON DIRECTED MODELS TO PROMOTE SKILL FLUENCY OR AUTOMATICITY Some prerequisite skills must be applied quickly and without conscious effort in order to be most useful. Gagné (1982) and Bloom (1986) referred to this automatic recall as **automaticity**. Students need rapid recall and performance of a wide range of skills throughout the curriculum, including simple math facts, grammar and usage rules, and spelling. Some students acquire automaticity through repeated use of the skills in practical situations whereas others acquire it more efficiently through isolated practice. Drill and practice, instructional games, and, sometimes, simulation courseware can provide practice tailored to individual skill needs and learning pace.

Table 2.3 Technology Integration Strategies Based on Directed Teaching Models

Integration Strategy	Needs and Problems Addressed	Example Activities
To remedy identified weaknesses or skill deficits	• Students need individual instruction and practice. • Students fail parts of high-stakes tests.	Tutorial or drill and practice software is targeted to identified skills.
To promote skill fluency or automaticity	• Students need to be able to recall and apply lower-level skills quickly and automatically. • Students need to review for upcoming tests.	Drill and practice or instructional game software lets students practice math facts, vocabulary, or spelling words.
To support efficient, self-paced learning	• Students are motivated and able to learn on their own. • No teacher is available for the content area.	Use tutorial software or distance learning courses for subjects.
To support learning and review of concepts	• Students need help studying for tests. • Students need make-up instruction for missed work.	Use tutorial, drill and practice, or podcasts to cover or review specific concepts.

Video Example 2.1 Using an Interactive Whiteboard in World History

In this video, you will see a teacher using an interactive whiteboard to project digital information and visuals to support his history lesson.

INTEGRATION STRATEGIES BASED ON DIRECTED MODELS TO SUPPORT EFFICIENT, SELF-PACED LEARNING When students are self-motivated and have the ability to structure their own learning, the most desirable method is often the one that offers the fastest and most efficient path. Sometimes these students are interested in topics not being covered in class or for which there is no instructor available. Directed instruction for these students can frequently be supported by well-designed, self-instructional tutorials and self-paced distance learning workshops and courses.

When students cover a number of topics over time, they usually need a review prior to taking a test to help them remember and consolidate concepts. Sometimes students are absent when in-class instruction was given or need additional time going over the material to understand and remember it. In these situations, drill and practice, tutorial software, and podcast materials are good ways to provide these self-paced reviews.

INTEGRATION STRATEGIES BASED ON DIRECTED MODELS TO SUPPORT LEARNING CONCEPTS Teachers often teach extensive content concepts through teacher-directed lectures. Some could use digital materials to support such teaching, such as using digital presentations, pictures, videos, and other digital materials that help represent the content to students.

Technology Integration Strategies Based on Constructivist Models

This section reviews the four integration strategies identified with constructivist methods. The strategies are summarized in Table 2.4.

INTEGRATION STRATEGIES BASED ON CONSTRUCTIVIST MODELS TO FOSTER CREATIVE PROBLEM SOLVING AND METACOGNITION Many people believe that our world is too complex and technical for students to learn everything they might need for the future. Thus, our knowledge society is beginning to place a high value on the ability to solve novel problems in creative ways. If students are conscious of the procedures they and others use to solve problems, they often can more easily improve on their strategies and become more effective, creative problem solvers.

Table 2.4 Technology Integration Strategies Based on Constructivist Models

Integration Strategy	Needs and Problems Addressed	Example Activities
To foster creative problem solving and metacognition	• Students need to be able to solve complex, novel problems as they occur. • Teachers want to encourage students' self-awareness of their own learning strategies.	• Video-based scenarios illustrate problems and help support student problem solving. • Concept mapping tools illustrate concepts and support student manipulation of variables. • Reflective thinking through blogging helps build metacognition. • Simulations allow exploration of how complex systems work.
To help build mental models and increase knowledge transfer	• Students have trouble understanding complex and/or abstract concepts. • Students have trouble seeing where skills apply to real-life problems.	• Video-based scenarios illustrate problems. • Serious games and simulations combine skill and knowledge building to solve lifelike challenges. • Virtual field trips and problem-solving software illustrate and let students explore complex environments or systems.
To foster group cooperation skills	• Students need to be able to work with others to solve problems and create products.	Students communicate and collaborate to: • Do effective Internet research. • Learn from diverse sources locally and globally. • Create multimedia expressions of learning. • Design solutions.
To allow for multiple and distributed intelligences	• Students need multiple ways to learn and to demonstrate achievement.	• Use collaborative online tools to facilitate group activities • Support peer-, teacher-, and media-based scaffolding through communicative technologies. • Accept a range of multimedia expressions of learning. • Knowledge expressions are built and distributed across group members.

Consequently, teachers often try to present novel problems (sometimes with unknown solutions) to students to solve and to get them to analyze how they learn to solve them. Resources such as problem-solving simulations and multimedia applications are often considered ideal environments for getting students to think about how they think and for offering opportunities to challenge their creativity and problem-solving abilities.

INTEGRATION STRATEGIES BASED ON CONSTRUCTIVIST MODELS TO HELP BUILD MENTAL MODELS AND INCREASE KNOWLEDGE TRANSFER The problem of inert knowledge is believed to arise when students learn skills in isolation. When they later encounter problems that require the skills, students do not realize how the skills could be relevant. Problem-solving materials in highly visual, interactive, and sometimes immersive formats allow students to build rich mental models of problems to be solved. For example, **serious games**, which teach skills and build knowledge in these highly visual, problem-solving environments, help ensure that students build higher order skills, retain understandings over time, and transfer knowledge to other problem contexts. These technology-based methods are especially desirable for teachers who work with students in areas such as mathematics and science whose concepts are abstract and complex and whose inert knowledge is a frequent focus.

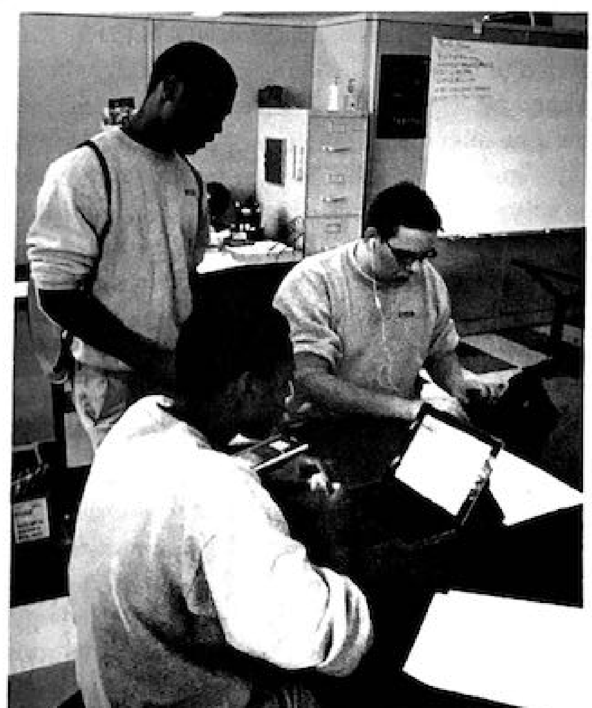
INTEGRATION STRATEGIES BASED ON CONSTRUCTIVIST MODELS TO FOSTER GROUP COOPERATION SKILLS Students need the ability to work cooperatively in a group to communicate and collaborate, construct knowledge, solve problems, and design solutions (Lynch, Lynch, & Bolyard, 2013; Schul, 2011; Wirth, 2013). Although schools certainly can teach cooperative work without technology resources, a growing body of evidence documents students' appreciation of cooperative work as both more motivating and easier to accomplish when it uses technology (Chin, 2013; Vargas, 2013). In Figure 2.5, three boys work cooperatively toward a shared learning goal.

Video Example 2.2 Using Geometer's Sketchpad for Inductive Reasoning

In this video, you will see a teacher and his students using Geometer's Sketchpad to find the centroid of a quadrilateral and testing it using cardboard.

INTEGRATION STRATEGIES BASED ON CONSTRUCTIVIST MODELS TO ALLOW FOR MULTIPLE AND DISTRIBUTED INTELLIGENCES Integration strategies with group cooperative activities also give teachers a way to allow students of widely varying abilities to make valuable contributions on their own terms. Because each student is an important member of the group in these activities, the activities themselves are viewed as problems for group—rather than individual—solution. This strategy foregrounds students' assets; engages peer-, teacher-, and media-based scaffolding as a way for students to accomplish tasks; and produces knowledge distributed across the group.

Figure 2.5 Three boys learning together with tablets



Technology Integration Strategies Useful for Either Model

We highlight four technology integration strategies that support instructional needs in both directed and constructivist models as summarized in Table 2.5.

INTEGRATION STRATEGIES USEFUL FOR EITHER MODEL TO GENERATE MOTIVATION TO LEARN Teachers say that capturing students' interest and enthusiasm is key to success; frequently, they cite it as their greatest challenge. Some educators assert that today's entertainment-immersed students are increasingly likely to demand more motivational qualities in their instruction than students in previous generations did. Constructivists argue that instruction must address students' affective needs as well as their cognitive ones, saying that students will learn more if what they are learning is interesting and relevant to their needs. They recommend the highly visual and interactive qualities of Internet and multimedia resources as the basis of these strategies. Proponents of directed methods make similar claims about highly structured, self-instructional learning environments. These individuals say that some students find learning at their own pace in a private environment very motivating because they receive immediate feedback on their progress. It seems evident that appropriate integration strategies to address motivation problems depend on the needs of the student; either constructivist or directed integration strategies can be used to increase motivation to learn.

INTEGRATION STRATEGIES USEFUL FOR EITHER MODEL TO OPTIMIZE SCARCE RESOURCES Current resources and numbers of personnel in schools are rarely optimal. Computer-based courseware and web-based materials can help make up for the lack of required resources—from consumable supplies to qualified teachers—in the school or classroom. For example, drill and practice programs can replace worksheets, a good distance program can offer instruction in topics for which local teachers are in

Table 2.5 Technology Integration Strategies to Support Either Model

Integration Strategies	Needs and Problems Addressed	Example Activities
To generate motivation to learn	• Students need motivation to learn. • Students need to see the relevance of new concepts and skills to their lives. • Students need to be active rather than passive learners.	• Visual and interactive qualities of the Internet and multimedia resources draw and hold students' attention. • Drill and practice/tutorial materials give students private environments for learning and practice. • Video-based scenarios and simulations show relevance of science and math skills. • Hands-on production work (e.g., multimedia, web pages) gives students an active role in learning.
To optimize scarce personnel and material resources	• Schools have limited budgets; therefore, they must save money on consumables or content materials. • Teachers are in short supply in some subject areas. • Students cannot travel to places to learn about them.	• Simulations allow repeated science experiments at no additional cost. • Distance courses can offer subjects for which schools lack teachers. • Rich content materials available on the web (e.g., NASA images) can extend textbook-based materials • Virtual tours allow students to see places which they could not go physically.
To reduce logistical hurdles	• Students find repetitive tasks (handwriting, calculations) boring and tedious. • Some design prototypes are too costly or time consuming to produce. • Some social and physical phenomena occur too slowly, too quickly, or at too great a distance to allow observation.	• Word processing makes quick, easy revisions and corrections to written work. • Calculators and spreadsheets do low-level calculations involved in math/science problem solving. • 3-D printers can be used to develop prototypes. • Simulations allow study of social systems (e.g., voting) and physical systems (chemical reactions).
To develop digital citizenship	• Students must understand and manage their digital identity. • Students must honor intellectual property of digital materials. • Students need to learn methods for communicating respectfully and safely online. • Digital content has varying quality and accuracy.	• Research reports as multimedia products or web pages must use copyright-free or Creative Commons digital content. • Students should track their digital identities, ensuring that no personal identifying information is available. • Methods for evaluating the accuracy, credibility, and relevance of online information should be implemented.

Video Example 2.3 Using the Quizdom System for Formative Assessment

In this video, you'll see how some teachers use clickers for formative assessment, which can motivate students by providing them immediate feedback on their learning.

short supply, an online fieldtrip can allow global visits, and a simulation program can let students repeat experiments without depleting chemical supplies or other materials.

INTEGRATION STRATEGIES USEFUL FOR EITHER MODEL TO REDUCE LOGISTICAL HURDLES Some technology tools offer no instructional sequence but help students complete learning tasks more efficiently than other tools. For example, word processing programs do not teach students how to write, but they let students write and rewrite more quickly without the labor of handwriting. Computer-aided design (CAD) software does not teach students how to design a house, but it allows them to try out designs and features to see what they look like before building models or structures. A calculator lets students do lower-level calculations so they can focus on the high-level concepts of math problems. A website might contain only a set of pictures of sea life, but it lets a teacher illustrate concepts about sea creatures more quickly and easily than he or she could with books.

INTEGRATION STRATEGIES USEFUL FOR EITHER MODEL TO DEVELOP DIGITAL CITIZENSHIP Many teachers recognize the need for students to develop responsible, legal, and ethical digital practices in order to live and work in our digital, global world. As teachers adopt directed and constructivist technology integration strategies, they can inherently provide opportunities for students to practice and demonstrate digital citizenship. For example, when students develop digital, multimedia presentations, they must consider copyright and attributions for materials they incorporate. When using technology to communicate and collaborate with others near or far, students must develop positive and safe interactions online. As they use and create digital materials, students need to become aware of and manage their growing digital identity that is tied to everything they do online.

✓ **Check Your Understanding** 2.4

Turn-around Technology Integration Pedagogy and Planning (TTIPP) Model

This section introduces a model to help teachers plan to integrate technology into their teaching. Now that you know a range of technology integration strategies and the learning theories that gave rise to them, let's turn to how to choose the optimal strategies in practice. Any well-designed lesson takes planning. The Turn-around Technology Integration Pedagogy and Planning (TTIPP) model in Figure 2.6 is an everyday process model that is useful when teachers decide that they would like to try to use digital technologies for teaching or if they face requirements to use technology. This process enables selecting the best pedagogical strategies and technological resources to teach their curriculum.

Each step in the model's three phases helps ensure that technology use will be meaningful and successful in meeting learning needs through the process of building a revitalized curriculum that engages all students. Aspects of this TTIPP model are inspired by turn-around pedagogies, a term coined by Kamler and Comber (2005) to describe a process in which teachers engaged to revitalize their curriculum that re-engaged students (in particular, at-risk students) in content area learning, and has been applied to developing digital literacies by Alvermann, Hutchins, and McDevitt (2012). *Turning around* is a long-term, everyday process that involves teachers in (1) exploring their students' lived experiences and identifying how these experiences are assets for learning, (2) inquiring into research-based perspectives on equity and learning, and (3) examining students' learning challenges in relation to current pedagogy and curriculum that might not privilege all students' capabilities, knowledge, and interests. Teachers who innovate to engage learners and their parents characterize highly effective schools (Fullan, 2016; James, Connolly, Dunning, & Elliot, 2006; McLaughlin & Talbert, 2001). Kamler and Comber's research was situated within teacher research networks and thus emphasized continual sharing and learning with peer teacher colleagues. We have integrated aspects of turn-around pedagogies into our TTIPP model.

Teachers experienced in using technology might perform these TTIPP steps intuitively. However, for new teachers or those just beginning to integrate technology, the TTIPP model provides a helpful guide on procedures and issues to address. The following sections discuss each of its component steps and give examples of tasks and products required in each step. As you read about the TTIPP model, we illustrate the phases through a classroom example of a teacher, Ms. Mian, building an online multicultural project.

Figure 2.6 The Turn-around Technology Integration Pedagogy Planning Model

Phase 1: Analysis of Learning and Teaching Assets and Needs
Step 1: Analyze problems of practice (POPs)
Step 2: Assess technological resources of students, families, teachers, and the school
Step 3: Identify technological possibilities

Phase 2: Design of the Integration Framework
Step 4: Decide on learning objectives and assessments
Step 5: Design integration strategies and determine relative advantage
Step 6: Prepare the instructional environment and implement the lesson

Phase 3: Post-Instruction Analysis and Revisions
Step 7: Analyze lesson results and impact
Step 8: Make revisions based on results
Step 9: Share lessons, revisions, and outcomes with other peer teachers

Phase 1: Analysis of Learning and Teaching Assets and Needs

In this phase of technology integration, teachers analyze teaching and learning problems, identify current technological assets, and determine the possible technologies that might address the problems. This section describes Phase 1 analysis steps and explains why each is necessary.

STEP 1: ANALYZE PROBLEMS OF PRACTICE (POPS) Every teacher has topics—and sometimes whole subject areas—that have proven challenging to teach. Some concepts are so abstract or foreign to students that they struggle to understand them; some students find some topics so boring, tedious, or irrelevant that they have trouble attending to them. Some learning requires time-consuming tasks that students resist doing. Good teachers try to meet these challenges by making concepts more engaging or easier to grasp, making tasks more efficient to accomplish, or completely rethinking curriculum goals. The first step in planning for technology integration is to identify problems in your practice that need changing.

- **What is the meaningful problem of practice?** To make sure a technology application is a good solution, begin with a clear statement of the teaching and learning problem. This is sometimes difficult to do but is essential to ensure that technology adoptions solve problems. Use the following guidelines when answering the question "What is a meaningful problem of practice?"
  - *Focus on discipline-specific knowledge, skills, or dispositions* that reveal difficulty in students' learning or the teacher's instruction of important disciplinary concepts. These problems would significantly impair students from successful progression in the discipline.
  - *Assess the nature and frequency of the disciplinary learning activities* for real-world relevancy and deep learning, often achieved through inquiry, critical thinking, complex problems, collaboration, and creative solutions.
  - *Examine the students' roles in learning*, determining whether students have some level of agency, autonomy, and engagement in learning activities.
  - *Look for observable indications* of the problem, such as student test scores revealing consistently lower achievement in a knowledge area; formal or informal observations showing teachers have trouble explaining concepts; or the school's adopting a new curriculum.

STEP 2: ASSESS TECHNOLOGICAL RESOURCES OF STUDENTS, FAMILIES, TEACHERS, AND THE SCHOOL A successful technology-enhanced lesson requires leveraging student technological strengths, teacher technology knowledge and skills, and school-based technological resources (i.e., hardware, software, other media, and support) to turn around the problems identified in Step 1. First, teachers must understand the technological experiences of their students, their families, and the communities in which the school is located. Second, teachers need to take stock in their own technological knowledge, such as considering their depth of knowledge of technological pedagogical content knowledge (TPCK) (review Figure 1.4). Third, teachers must assess the technological resources available in their school and classroom. You will garner more success if you plan technology integration with supporting conditions in mind. That means asking the following questions:

- **Question 1: Who are my students as digital technology users and what are they capable of doing with technology?** To help you design technology-supported lessons, knowing the nature of digital practices that your students engage in is worthwhile. You can come to understand their digital capabilities and access to technology equipment, software, and the Internet in and out of school. Your students could have a range of technological activity sites, including their homes, their parent's workplaces, community libraries or centers, and homes of other family members or friends in addition to what occurs in school. The digital knowledge they possess are assets that you can capitalize on in lesson planning, and the digital knowledge they lack can also inform you about digital literacy practices that will need to be taught in advance of or during a lesson. We suggest the following sources for assessing this information:

- *Surveys or questionnaires*—Check with your school to determine whether it collects any information on digital practices of students or parents through surveys or questionnaires, such as participation in ED School Climate Surveys (EDSCLS), Project Tomorrow's annual Speak Up survey, non-profit YouthTruth's STEM survey, or other state or local surveys. As a teacher, you could create a questionnaire specific to your interests using free survey software and access to a range of survey questions, such as those in Speak Up or Pew Research Center's Internet and Tech surveys.
- *Home/community visits*—If time was available, teachers have found home visits or community walks to be immensely valuable in understanding more about the students they teach. Cremin, Mottram, Collins, Powell, and Drury (2012) called these "learner visits" (p. 104) and found that they challenged teachers' preconceived perceptions of the students and their families. Likewise, the students in your classroom could hail from a range of communities, so taking walks and observing life in these areas proves informative. Be sure to visit the libraries and community centers.
- *Student Share*—Teachers can also invite students to select digital artifacts they have created outside of school and teach the class about its creation. Alternatively, teachers could set up a collaborative online sharing space, such as a cloud-based storage area or folder in a learning management software to which students could upload and annotate their digital artifacts.

- **Question 2: What are my technical knowledge, skills, and attitudes?** Teachers must self-assess their own technological knowledge, skills, and attitudes in order to identify strengths and weaknesses as they begin to plan for technology integration. This assessment in the case of identified strengths is a source for technological ideas for lessons. In the case of identified weaknesses, the assessment can lead to areas for further professional learning or opportunities for collaboration with other teachers, librarians, and media specialists who might have more expertise. As an example, Shelby-Caffey, Úbéda, and Jenkins (2014) highlight the process that a teacher, Bethany, undertook to turn around her technophobic beliefs and practices and embrace digital storytelling as a way to transform her teaching and the students' learning. As part of a grant that provided classroom technologies, she received training and ongoing support that pushed her out of her technophobic comfort zone.
- **Question 3: What technology resources exist in my school?** Remember that this textbook defines technology resources as technology tools (e.g., media, software, and hardware) and technology support and expertise. As you join a school, assess the resources available. You can obtain this information from school leaders, librarians, media specialists, and your peer teachers. Consider the following:
  - *Computers and Internet*—Are there enough computers available to support individual computing, pairs, small groups, or whole class? Is there a computer laboratory? Are there mobile carts of computers or tablets? What is the availability of access to these computing resources, and how can you reserve them? How robust is the Internet in your classroom?
  - *Software and media*—What software, media packages, or apps are available? Remember that making copies of published software or media is illegal, even if copies are used on a temporary basis.
  - *Peripherals*—What is the access to printers, paper, and other special peripherals such as scanners, digital cameras, video cameras and headphones?

- *Technology support*—Who do you ask for help when you have technical difficulties, such as crashing computers, printer errors, or projector malfunctions? How is best to contact these individuals—through the phone, email, or a help center?
- *Technology integration expertise*—Who has expertise with technology integration that might be available for idea brainstorming, lesson plan development, or co-teaching? What is the availability of these experts and how can you schedule time with them?

STEP 3: IDENTIFY TECHNOLOGICAL POSSIBILITIES In Step 3, you need to identify technological possibilities for solving the problem of practice. Technology-based strategies offer many benefits to teachers as they look for instructional solutions to this problem. Being able to recognize specific instances of these problems in a classroom context and knowing how to match them with an appropriate technology solution require knowledge of classroom problems, practice in addressing them, and an in-depth knowledge of the characteristics of each technology. With the problem of practice that you have identified in your own classroom, use your knowledge of learning theories, technology resources at your school from Step 2, and integration strategies described in Tables 2.2 through 2.4 to identify possible technology solutions to your problem of practice. Inherent in these possibilities, you will determine whether your new methods should be primarily directed or constructivist:

- *Use directed strategies* when students need an efficient way to learn specific skills that must be assessed with traditional tests.
- *Use constructivist strategies* when students need to develop global skills and insights over time (e.g., cooperative group skills, approaches to solving novel problems, mental models of highly complex topics) and when learning may be assessed with alternative measures, such as portfolios or group products.

Read how Ms. Mian, the teacher, moves through the steps in Phase 1 of TTIPP in Technology Integration Example 2.1.

Phase 2: Design of the Integration Framework

This phase requires teachers to make decisions about learning objectives and how they will be assessed, how to arrange and carry out integration strategies, and how technology integration provides a relative advantage over past approaches.

STEP 4: DECIDE ON LEARNING OBJECTIVES AND ASSESSMENTS Writing learning objectives is a good way to set clear expectations for what technology-based methods will accomplish (i.e., outcomes) and to allow later measurement of how much these expectations have been met (i.e., assessment). For example, teachers may expect that a new method will improve student behaviors, which will result in better achievement, more on-task behavior, or improved attitudes. Sometimes changes in teacher behaviors are important—for example, saving time on a task or helping to re-engineer curriculum. In either case, objectives should focus on outcomes that are observable (e.g., demonstrating, writing, completing, re-engineering) rather than on internal results that cannot be seen or measured (e.g., being aware, knowing, understanding, or appreciating).

After stating learning objectives, teachers create ways to assess how well outcomes have been accomplished. Sometimes, they can use existing assessment instruments. In other cases, they have to create instruments or methods to measure the behaviors. Here are a few example outcomes, objectives (which are used to state outcomes in a measurable form), and assessment methods matched to the outcomes:

- **Higher achievement outcome**—Overall average performance on an end-of-chapter test will improve by 20%. (Assess achievement with a test.)
- **Cooperative work outcome**—All students will score at least 15 of 20 on the cooperative group skill rubric. (Use an existing rubric to assess skills.)

Technology Integration

Example 2.1

TTIPP Phase 1 Analysis of Learning and Teaching Assets and Needs

Ms. Mian wanted to include more meaningful multicultural activities in the social studies curriculum because she and the other social studies teachers in her school focused primarily on studying various holidays and foods from other cultures. The teachers sponsored an annual international foods smorgasbord that was very popular with the students, but she doubted that it taught them much about the richness of other cultures or why they should respect and appreciate cultures different from their own. She sometimes overheard her students making disparaging comments about people in other ethnic groups and felt a better approach to multicultural education might help.

Ms. Mian remembered a workshop she had attended the previous summer in which teachers in another school district described an online project with partner schools in countries around the world. One teacher told about her partners in Israel, Spain, Mexico, and Kenya and said that students exchanged information with designated partners and answered assigned questions to research each other's backgrounds and locales. Then the students worked in groups to make travel brochures or booklets to email to each other. They even took digital photos and videos of themselves to send. It sounded like a great way for kids to learn about other cultures in a meaningful way while learning some geography and civics. The teachers in the workshop had remarked that it was difficult to demean people who look and talk differently than you do when you've worked with and gotten to know them. Ms. Mian was so impressed with the online project they had described that she decided to try it out in her own classroom. She knew her school had robust Internet and tablet access with a range of media software. Most of her students had used email and multimedia software outside of school. Even though she had not seen it modeled, she felt she could structure a good curriculum around these activities once she knew about what was needed.

Phase 1 Analysis Questions

1. What is the problem of practice Ms. Mian wants to address?
2. What evidence does she have that there is a problem?
3. What technological assets do students possess that could be used in a lesson?
4. What technology resources exist at the school that might support technological solutions to the problem?
5. What technological possibility does Ms. Mian identify to solve this problem of practice?
6. What special skills or resources does Ms. Mian need to implement such a project?

- **Attitude outcome**—Students will indicate satisfaction with the simulation lesson by an overall average score of 20 of 25 points. (Create an attitude survey to assess satisfaction.)
- **Improved motivation**—Teachers will observe better on-task behavior in at least 75% of the students. (Create and use an observation sheet.)

Table 2.6 offers a range of resource suggestions for meeting assessment activities.

This step in Phase 2 requires answering two questions about outcomes and assessment strategies:

- **Question 1: What outcomes do I expect from using the new methods?** Think about problems you are trying to solve and what would be acceptable indications that the technology solution has succeeded in resolving them. Use the following guidelines:
  - *Focus on results, not processes*—Think about the end results you want to achieve rather than the processes to help you get there. Avoid statements that focus on a process that students use to achieve an outcome, such as "Students will learn cooperative group skills." Instead, state what you want students to be able to do as a result of having participated in the multimedia project—for example, "90% of students will score 4 of 5 on a cooperative group skills rubric."
  - *Make statements observable and measurable*—Avoid vague statements that cannot be measured; for example, "Students will understand how to work cooperatively."

Table 2.6 Assessment Resources for Teachers

Assessment Activity	Resources
Online surveys (most have a free, limited-feature option as well as a fee-based option)	• Qualtrics • Google Forms • SurveyMonkey • Zoomerang • SurveyMethods • Kahoot!
Rubric makers and free prepared rubrics	• Kathy Schrock's Guide to Everything • RubiStar • iRubric app
Testmakers and quiz makers	• ContentGenerator.net • QuizStar • Qzzr • Engageform

- **Question 2: What are the best ways to assess these outcomes?** The choice of assessment method depends on the nature of the outcome. Note the following guidelines:
  - *Use tests to assess skill achievement outcomes*—Cognitive tests (e.g., short answer, multiple choice, true/false, matching) and essay exams remain the most common classroom assessment strategy for many formal knowledge skills.
  - *Use evaluation criteria checklists to assess complex tasks or products*—When students must create complex products, such as multimedia presentations, reports, or web pages, teachers can give students a multimedia checklist like the one shown, which is a set of criteria that specify the requirements each product must meet, to guide their project. The teacher uses the criteria to award points for meeting each criterion.
  - *Use rubrics to assess complex tasks or products*—Rubrics like the one shown fulfill the same role as evaluation criteria checklists and are sometimes used in addition to them. A **rubric** is an instrument consisting of a set of elements that define important aspects of a given performance or product and provide ratings that describe levels of quality for each element. Rubrics' added value is giving students descriptions of various levels of quality. Teachers usually associate a letter grade with each level of quality (Level 5 = A, Level 4 = B, etc.).
  - *Use Likert scale–type surveys or semantic differentials to assess attitude outcomes*—When the desired outcome is to improve attitudes, teachers design a survey in Likert scale format or with a **semantic differential**. A **Likert scale** is a series of statements that students use to indicate their degree of agreement or disagreement. A semantic differential requires students to respond to a question by checking a line between each of several sets of bipolar adjectives to indicate their level of feeling about the topic of the question. The teacher sums the item scores on these surveys or semantic differentials to obtain a measure of student perceptions.

  Teachers use observation instruments to measure frequency of behaviors. For example, if teachers wanted to see an increase in students' use of scientific language, they could create a chart to keep track of this use on a daily basis so they could track baseline performance and improvement over time.

Some technologies, such as drill and practice software or adaptive learning software, have built-in formative and summative assessments of students' knowledge.

STEP 5: DESIGN INTEGRATION STRATEGIES AND DETERMINE RELATIVE ADVANTAGE What usually drives integration design decisions is whether the learning environment will be primarily directed (a teacher or expert source presents information for students to absorb) or primarily constructivist (students do activities to generate their own learning). In light of this decision, which you made in Step 3, consider each of the following implementation decisions to narrow down your integration strategy:

Video Example 2.4 Technology Support for Assessment Strategies

In this video, this principal talks about how technology can support appropriate and efficient assessment strategies. What are some of the benefits of assessing students in this way?

- **Question 1: What kind of content approach do I need to use?** Should the approach be a single subject or interdisciplinary? Sometimes school or district requirements dictate this decision, and sometimes teachers combine subjects into a single unit of instruction as a way to cover concepts and topics they may not otherwise have time to teach. Most often, however, interdisciplinary approaches are used to model how real-life activities require the use of a combination of skills from several content areas.
- **Question 2: What grouping approach should I use?** Should the students work as individuals, in pairs, in small groups, or as a whole class? This decision is made in light of how many computers or software copies are available as well as the following purposes:
  - *Whole class*—For demonstrations or to guide whole-class discussion prior to student work.
  - *Individual*—When students have to demonstrate individual mastery of skills at the end of the lesson or project.
  - *Pairs*—For peer tutoring when higher ability students work with those of lower ability or for collaboration in dyads.
  - *Small group*—To model real-world work skills by giving students experience in cooperative group work.
- **Question 3: How can I prepare students adequately to use technologies?** When designing a sequence of activities that incorporates technology tools, be sure to consider your students' technological assets and needs. Allow enough time for demonstrating the tools to students and allowing them to become comfortable using them before they do a graded product.

Once you have an integration strategy, you are ready to consider the benefits of new technology methods compared to the past ones and decide whether there will be significant benefits. Everett Rogers (2003), an expert on why and how people adopt innovations, called this seeing a **relative advantage.** Hughes (2000; 2005) developed the Replacement, Amplification, and Transformation (RAT) assessment model to help teachers assess, or RATify, the relative advantage of technology-supported lessons. During the assessment, a teacher should examine the following three aspects of the lesson in which the technology use will be embedded: (1) instructional method, (2) student learning processes, and

(3) curriculum/content goals. Hughes developed three use categories from educational theory, classroom observations, and interviews with teachers. They include:

- **Replacement**—Technology used as replacement replicates and does not change established instructional practices, student learning processes, or content goals. The technology serves merely as a different, technological means to the same instructional end. Think of technology as a proxy, stand-in, or surrogate.
- **Amplification**—Technology used as amplification increases efficiency or intensifies productivity in current instructional practices, student learning, or content goals (Cole & Griffin, 1980; Pea, 1985). The focus is effectiveness or streamlining rather than change. Cuban (1988) described this as a first-order change for which technology is used to "try to make what exists more efficient and effective without disturbing the basic organizational features . . . " (p. 93). Fishman and Dede (2016) refer to this as "doing conventional things better" (p. 1269). Think of technology as enlargement (larger, greater, stronger), addition of detail (fuller, clearer), or increase in magnitude.
- **Transformation**—Technology used for transformation shifts, restructures, or reorganizes instructional methods, the students' learning processes, and/or the actual subject matter in ways unavailable without the inclusion of the technology (Pea, 1985). Transformation is akin to Cuban's (1988) notion of second-order changes that produce "new goals, structures, and roles that transform familiar ways of doing things into novel solutions to persistent problems" (p. 94). Fishman and Dede (2016) frame this as "doing better things" (p. 1269) by completely rethinking how learning and instruction may occur with technologies. Think of technology as change, conversion, revolution, renovation, restructure, and reorganization.

To RATify a technology's contribution to a lesson, a teacher can use the RAT matrix to guide consideration of how an instance of technology use impacts instructional methods, student learning processes, and curriculum goals, each of which can be further articulated by identifying more specific dimensions within each.

Hughes developed the RAT model and matrix for use by teachers who are planning or have taught technology-supported lessons. Individual digital technologies (e.g., PowerPoint, an ELMO, GIS software) cannot be assessed using the RAT model without the rich instructional information about the context of a digital technology's use in teaching and learning. The model supports teacher assessment of lessons because the rich instructional information is typically known only by the teacher or someone who co-planned, co-observed, or co-teaches with the teacher.

We exemplify using the RAT matrix to assess the role of technology in a lesson richly described by Conn (2013). In this lesson, a first grade teacher integrated the use of live web-cam video of animals living in captivity and wild habitats for a unit on habitats. For 5 weeks, students used iPads to observe animals daily, note characteristics, and research habitats. The lesson culminated with an illustrated report (see Figure 2.7).

The RAT categories do not provide a linear path to technology integration such as starting with R activities, then moving to A, and ultimately to T. Research shows that teachers will have an array of R, A, and T technology integration practices in their teaching but transformative practices are sometimes elusive (Blanchard, LePrevost, Tolin, & Gutierrez, 2016; Gao, Chee, Wang, Wong, & Choy, 2011; Hughes, 2005; Kimmons, Miller, Amador, Desjardins & Hall, 2015; Russell & Hughes, 2014). Transformative technology integration emerges from planning processes that privilege subject matter content as when subject-area teachers explore subject problems of practice and explore digital technology as possible solutions (Hughes & Ooms, 2004).

Table 2.7 lists several kinds of learning problems and technology possibilities with potential for high relative advantage.

Figure 2.7 RATifying the Conn (2013) Lesson with the Replacement, Amplification, Transformation (RAT) Matrix

	Instruction	Learning	Curriculum
Replacement Technology is different means to same end.		• Read magazines online • Drew habitat in a drawing app • Wrote report about habitat in writing app	• Met 1st grade science standards-observing and comparing habitats
Amplification Technology increases or intensifies efficiency, productivity, access, and capabilities, etc., but the tasks stay fundamentally the same.	• More efficient everyday access to video streams with iPads vs. computer lab • Increased variety of live habitats	• Customized habitat sorting activity in app	
Transformation Technology redefines, restructures, reorganizes, changes, or creates novel solutions.	• Changed length of time habitats could be observed (5 weeks)	• Created a real-world, authentic observational experience for learners	• Lesson became interdisciplinary with science, research, reading, writing, and technology

The degree to which these solutions might replace, amplify, or transform your practice depends on your specific teaching context. RATifying your technology-supported lessons enables you to understand the technology's advantage relative to past practices. If you are not satisfied with the ways in which your technology-supported lesson will provide a relative advantage, you can go back to Step 3 to reconsider other technological possibilities and continue through the TTIPP steps in sequence.

STEP 6. PREPARE THE INSTRUCTIONAL ENVIRONMENT AND IMPLEMENT THE LESSON This step requires answering two questions about preparing an instructional environment that will support technology integration:

- **Question 1: How should resources be arranged to support instruction and learning?** Guidelines here include:
  - *Access for students' needs*—For students with visual, hearing, physical, or cognitive differences, consider software or adaptive devices created especially to address these needs. An important concern here is universal design for learning (UDL). For more on this, see the Adapting for Special Needs feature in Box 2.1.

Video Example 2.5 Planning for Technology Integration

Watch the video and listen to one teacher talk about planning as a creative problem-solving process. What is the relative advantage in her rationale for deciding to use video in her lessons?

Table 2.7 Technology Possibilities with Potential for High Relative Advantage

Problems of Practice	Technology Possibilities	Relative Advantage
Concepts are new, foreign (e.g., mathematics, physics principles)	Graphic tools, simulations, video-based problem scenarios	Visual examples clarify concepts and applications.
Concepts are abstract, complex (e.g., physics principles, biology systems)	Math tools (Geometer's SketchPad, simulations, problem-solving software, spreadsheet exercises, graphing calculators)	Graphics displays make abstract concepts more concrete; students can manipulate systems to see how they work.
Time-consuming manual skills (e.g., handwriting, calculations, data collection) interfere with learning high-level skills	Tool software (e.g., word processing, spreadsheets and probeware)	Takes low-level labor out of high-level tasks; students can focus on learning high-level concepts and skills.
Students find practice boring (e.g., basic math skills, spelling, vocabulary, test preparation)	Drill and practice software, instructional games	Attention-getting displays, immediate feedback, and interaction combine to create motivating practice.
Students cannot see relevance of concepts to their lives (e.g., history, social studies)	Simulations, Internet activities, video-based problem scenarios	Visual, interactive activities help teachers demonstrate relevance.
Skills are "inert" (i.e., can do them—e.g., mathematics, physics—but do not see where they apply)	Simulations, problem-solving software, video-based problem scenarios, student development of web pages, multimedia products	Project-based learning using these tools establishes clear links between skills and real-world problems.
Students dislike preparing research reports, presentations	Student development of desktop-published and web page/multimedia products	Students like products that look polished, professional.
Students need skills in working collaboratively, opportunities to demonstrate learning in alternative ways	Student development of desktop-published and web page/multimedia products	This provides a format in which group work makes sense; students can work together "virtually"; they make different contributions to one product based on their strengths.
Students need technological competence in preparation for the workplace	All software and productivity tools; all communications, presentation, and multimedia software	Illustrates and provides practice in skills and tools students will need in work situations.
Teachers have limited time for correcting students' individual practice items	Drill and practice software, handheld computers with assessment software	Feedback to students is immediate; frees teachers for work with students.
No teachers available for advanced courses	Self-instructional multimedia, distance courses	Provides structured, self-paced learning environments.
Students need individual reviews of missed work	Tutorial or multimedia software	Provides structured, self-paced environments for individual review of missed concepts.
Schools have insufficient consumable materials (e.g., science labs, workbooks)	Simulations, e-books	Materials are reusable; saves money on purchasing new copies.
Students need quick access to information and people not locally available	Internet and email projects; multimedia encyclopedias and atlases	Information is faster to access; people are easier, less expensive to contact.

Box 2.1: Adapting for Special Needs: Universal Design for Learning

Universal design for learning (UDL) is a framework that has important implications for technology use in the classroom. UDL proactively addresses academic diversity through strategies that offer students multiple ways to access, engage, and demonstrate their mastery of the learning outcomes. One of the mantras of UDL is that instructional design deliberately created for individuals with disabilities often provides significant benefits to all students. The essence of UDL involves providing three components:

- Multiple means of representation to give learners various ways of acquiring information and knowledge
- Multiple means of engagement to tap into learners' interests, to challenge them appropriately, and to motivate them to learn
- Multiple means of expression to provide learners with alternatives for demonstrating what they know

Traditionally, when educators fail to recognize that 25–50% of the students in their classroom might not read at grade level, they distribute textbooks that have a readability level *above* grade level. However, using the principle of multiple means of representation, an educator plans instruction to provide access to digital text so that students can manipulate the physical nature of the text (e.g., change the font size, color contrasts), as well as alter the cognitive difficulty by using tools such as text-to-speech (e.g., Natural Reader website) or text-summarization (e.g., Text Compactor website). Learn more about universal design for learning in order to understand its applications for your own classroom by visiting the Center for Applied Special Technology or CAST website.

—Contributed by Dave Edyburn

- *Privacy and safety issues*—Ensure you uphold technology use policies. You may need to remind students of guidelines for acceptable technology use, especially when you use the Internet. These policies hold students accountable for equipment and their actions while using technology.
- *Classroom management*—You need to anticipate and develop strategies to manage students' behavior when technology is in use. Your knowledge of how much time is required to teach particular technologies and how many of your students will need the technology instruction will reveal students who may need other different assigned tasks. Further, the more you can envision or anticipate potential student problems with the technologies, the more focused supporting materials you can provide.
- *Supporting materials*—Prepare, copy (or post), or model necessary support materials. You can consider creating summary sheets to remind students how to do basic operations, create or link to "how-to" videos (e.g., lynda.com or Atomic Learning), or be prepared to model and explain technology procedures.

- **Question 2: What steps are required to make sure technology resources work well?** Guidelines here include:
  - *Troubleshooting*—Computers, like all machines, occasionally break down. Learn simple diagnostic procedures so you can correct some problems without assistance. Know whom to contact and how to receive technical support in your classroom.
  - *Test runs*—Spend time learning and practicing using resources before students use them, but also retry the resources just before class begins.
  - *Backup alternatives*— Have a backup plan in case something goes wrong at the last minute.

With knowledge of your learning objectives, prepared assessments, chosen integration strategies, and prepared instructional environment, you are ready to implement your technology-supported lesson! Read how Ms. Mian, the teacher, engaged in designing her integration framework for her multicultural unit in Technology Integration Example 2.2.

Phase 3: Post-Instruction Analysis and Revisions

This section gives a detailed description of Phase 3 steps and an explanation of why each is necessary. As teachers complete a technology-supported project with students, teachers begin reviewing evidence of how successful the strategies and plans were in solving the identified problems. Teachers use this evidence to decide what should be changed with respect to objectives, strategies, and implementation tasks to ensure even more success next time. Their results can be shared with colleagues.

STEP 7. ANALYZE LESSON RESULTS AND IMPACT To do a post-instruction analysis, teachers look at the following issues:

- **Were the objectives achieved?** This is the primary criterion of success of the activity. Teachers review achievement, attitude, and observation data they have collected and decide whether the technology-based method solved the problem(s) they had identified. These data help them determine what should be changed to make the activity work better.
- **What do students say?** Some of the best suggestions on needed improvements come from students. Informal discussions with them yield a unique student perspective on the activity.

Technology Integration

Example 2.2

TTIPP Phase 2 Design of the Integration Framework

Ms. Mian reflected on the problems she saw with her current multicultural goals and what she wanted her students to learn about other cultures that they didn't seem to be learning. She decided on the following three learning outcomes: better attitudes toward people of other cultures, increased learning about similarities and differences among cultures, and knowledge of facts and concepts about the geography and government of the other country they would study. So that she could measure the success of her project later, she created objectives and instruments to measure the outcomes:

- **Attitudes toward cultures**—At least 75% of students will demonstrate an improved attitude toward the culture being studied with a higher score on the post-unit attitude measure than on pre-unit measure. Instrument: She knew a good way to measure attitudes was with a semantic differential. Before and after the project, students would answer the question: "How do you feel about people from __________?" by marking a line between sets of adjectives to indicate how they feel.
- **Knowledge of cultures**—Each student group will score at least 90% on a rubric evaluating the brochure or booklet that reflects knowledge of the cultural characteristics (both unique and common to our own) about the people being studied. Instrument: After listing characteristics she wanted to see reflected in the products, she found a product rubric to assess them. She decided they should get at least 15 of the 20 possible points on this rubric.
- **Factual knowledge**—Each student will score at least 80% on a short-answer test on the government and geography of the country being studied.

Next, Ms. Mian designed the integration strategies. She knew that her students would not achieve the insights and changed attitudes she had in mind using the strategy of telling them information and testing them on it. They would need to draw their own conclusions by working and communicating with people from other cultures. However, she felt she could use a directed approach to teach them the Internet and email skills they would need to carry out project activities. The project website suggested setting up groups of four with designated tasks for each group member. It also suggested the following sequence of activities for introducing and carrying out the project:

Step 1: Teacher signs up on the project website; obtains partner school assignments.
Step 2: Teachers in partner schools make contact and set a timeline.
Step 3: Teachers organize classroom resources for work on project.
Step 4: Teacher introduces the project to students: Displays project information from the website and discusses previous products that appear on other sites.
Step 5: Teacher assigns students to groups; discusses task assignments with all members.
Step 6: Teacher determines students' email and Internet skills; begins teaching those skills needed.
Step 7: Students make initial email contacts/chats and introduce themselves to each other.
Step 8: Teacher works with groups to identify information for final product.
Step 9: Students search the Internet to locate required information; take digital photos and scan required images; exchange information with partner sites.
Step 10: Students do production work; exchange final products with partners.
Step 11: Teacher debriefs and assesses student work.

Next, Ms. Mian took time to identify the relative advantage of the proposed online project by using the RAT model. When she thought deeply about the role(s) technology played in the lesson, she RATified it in the following way:

	Instruction	Learning	Curriculum
Replacement Technology is a different means to same end.			• Teach facts about geography and government
Amplification Technology increases or intensifies efficiency, productivity, access, and capabilities etc., but the tasks stay fundamentally the same.		• Use Internet to research facts about countries	• Teach about digital citizenship: email communication and Internet research
Transformation Technology redefines, restructures, reorganizes, changes, and creates novel solutions.	• Collaborate with teachers in other countries to co-teach a lesson	• Use video, pictures, email communication to build and share cultural knowledge • Use team-based work • Produce digital products	• Move beyond culture simply by addressing food and holidays • Experience and exchange cultural knowledge with cultural insiders in other countries

Based on her RATification of the lesson, Ms. Mian felt this online project was worthwhile, so she began to prepare her instructional environment. First, she examined the timeline of project activities so she would know when her students needed to use computers. She made sure to build in enough time to demonstrate the project site and to prepare her students to use the browser and search engine responsibly. Then she began the following planning and preparation activities:

- **Supports for students**—To make sure that groups knew the tasks each member should do, Ms. Mian created handouts specifying timelines and what should be accomplished at each stage of the project. She also made a checklist of information that students were to collect and made copies so that students could check off what they had done as they went along. She wanted to make sure everyone would know how she would grade their work, so she made copies of the assessments (the rubric and a description of the country information test) that she would hand out and discuss with the students.
- **Computer schedule**—Ms. Mian had five Internet-connected computers, so she set up a schedule for small groups to use the computers. She knew that some students would need to scan pictures, download image files from the digital camera, and process those files for sending to the partner schools, so she scheduled some additional time in the computer lab for this work. She thought that students could do other work in the library/media center after school if they needed still more time.

Phase 2 Analysis Questions

1. What are Ms. Mian's learning objectives for the lesson?
2. What kinds of assessments is Ms. Mian using to assess the outcomes of her lesson?
3. Is Ms. Mian's lesson strategy primarily directed or constructivist?
4. What grouping strategy did Ms. Mian choose? Why?
5. Do you see any other relative advantages of the online project she is proposing: Are there other ways this lesson replaces, amplifies, or transforms practice?
6. Ms. Mian was concerned about students revealing too much personal information about themselves to people in their partner schools. What guidelines should she give them about information exchanges to protect their privacy and security?

- **Could improving instructional strategies improve results?** Technologies in themselves do not usually improve results significantly; it is the way teachers use them that is critical. Look at the design of both the technology use and the learning activities surrounding it.
- **Could improving the environment improve results?** Sometimes a small change, such as better scheduling or access to a printer, can make a big difference in a project's success.
- **What is the contribution of the technology to instruction, student learning, or curriculum content? How well has the technology integration strategy worked?** Refer to how you RATified your lesson during Step 5. Did the technology replace, amplify, or transform instruction, learning, and curriculum as you expected? You can also use the Assessment Tools: Technology Impact Checklist to determine how the activity has added relative advantage as compared to what you have done before.

  Check the available data you have:
  - *Achievement data*—If the problem was low student achievement, do data show that students are achieving better than they were before? If the goal was improved motivation or attitudes, are students achieving at least as well as they did before? Is higher achievement consistent across the class, or did some students seem to benefit more than others?
  - *Attitude data*—If the original problem was students' low motivation or refusal to do required work, are there indications that this behavior has improved? Has it improved for everyone or just for certain students?
  - *Students' comments*—Be sure to ask both lower-achieving, average-achieving, and higher-achieving students for their opinions. Even if achievement and motivation seem to have improved, what do students say about the activity? Do they want to do similar activities again?

- **What could be improved to make the technology integration strategy work better?** The first time you engage in a technology-based activity, you can expect that it will take longer and you will encounter more challenges than you will in subsequent uses. The following areas are most often cited as needing improvement:
  - *Scheduling*—If students request any change, it is usually for more time. This may or may not be feasible, but you can review the schedule to determine whether additional time can be built in for learning software and/or for production work.
  - *Technical skills*—It usually takes longer than expected for students to learn the technology tools. How can this learning be expedited or supported better?
  - *Efficiency*—From the teacher's point of view, the activity took longer than expected to plan and carry out. If the impact on outcomes is significant, the extra time may be worth it.

STEP 8. MAKE REVISIONS BASED ON RESULTS Based on the results from Step 7, teachers make adjustments to materials, logistics, and/or strategies. Revision activities are on a continuum ranging from making small changes in how materials are used to going back to Step 1 and re-analyzing the problem–solution match. Evidence in the form of student outcomes must drive these decisions.

As a planning tool, the TTIPP model makes concrete the questions that teachers need to think through when designing instruction that uses technology. The combination of theory foundation and thoughtful planning make technology integration purposeful, effective, and meaningful for teachers and students alike.

STEP 9. SHARE LESSONS, REVISIONS, AND OUTCOMES WITH OTHER PEER TEACHERS All of your hard work planning and implementing a technology-supported lesson could have a significant impact on the students in your classroom. You can extend that impact by sharing your original or revised lesson with colleagues near and far. Collaboration with colleagues to share innovations in teaching and learning can powerfully motivate and engage teachers in the teaching profession (Fullan, 2016). McLaughlin and Talbert (2001) identified the fact that teachers were more persistent in innovating when they shared resources and practices collaboratively with colleagues.

Your school or district may have digital spaces for sharing lessons with other teachers; you could share with content-area organization sharing areas (e.g., listserv or websites); you can post it online and share a link to others on social networking sites such as Twitter; or you could even monetize your work by selling it on Teachers Pay Teachers as long as your district allows this. Read how the teacher, Ms. Mian, analyzed the results of her lesson and shared outcomes with her peers in Technology Integration Example 2.3.

Technology Integration

Example 2.3

TTIPP Phase 3 Post-Instruction Analysis and Revisions

Ms. Mian was generally pleased with the results of the multicultural project. According to the semantic differential, most students showed a major improvement in how they perceived people from the country they were studying. Students she had spoken with were very enthusiastic about their chats and email exchanges. Some group brochures and booklets were more polished than others, but they all showed good insights into the similarities and differences between cultures, and every group had met the rubric criteria on content. The web searches they had done seemed to have helped.

One thing that became clear was that production work on their published products was very time consuming; in the future, Ms. Mian would have to either assign a simpler product or change the schedule to allow more time. She also realized that she had to stress that the deadlines were firm. Students would have searched for and taken digital photos forever if she had let them. The searching activity put them behind on making their products and left little time to discuss their findings on comparisons of cultures. Results varied on the short-answer test on the geography of the country being studied. Only about half of the students met the 80% criterion. Ms. Mian realized she would have to schedule a review of this information before she gave the test. She decided to make this a final group task after the production work was finished.

Ms. Mian revised her planning documents with these results in mind so that she could implement this project again next year. She met with her grade-level team to share the results and discuss the lesson. They seemed intrigued by the project and in the shift in students' knowledge and attitudes. She also shared a revised version of her lesson with her media specialist who added it to a district online collaboration area for teachers that has a space to upload technology-supported lessons.

Phase 3 Analysis Questions

1. If Ms. Mian found that only five of the seven groups in the class were doing well on their final products, what might she do to find out more about why this was happening?
2. Although all of Ms. Mian's groups did well on content overall, rubric scores revealed that most groups scored lower in one area: spelling, grammar, and punctuation in the products. What steps could Ms. Mian take to revise the production work checklist that might improve this outcome next time?
3. What benefits might Ms. Mian experience by sharing her lesson with others

✓ **Check Your Understanding 2.5**

Shared Writing 2.2 Technology Integration Evaluation Resources

Chapter 2 Summary

1. **Overview of successful technology integration planning and practice**—Two learning theories have given rise to two types of integration models: directed and constructivist. A turn-around technology integration pedagogy and planning model requires knowledge of learning theories to enable transformative technology integration planning.
2. **Directed integration models were shaped by objectivist theories**—Leading theories included behaviorist (Skinner), information-processing (Atkinson and Shiffrin), cognitive-behavioral (Gagné), and systems theories. Directed technology integration strategies are typically systematically designed, structured learning products such as drills, tutorials, and adaptive or personalized learning systems.
3. **Constructivist integration strategies were based on constructivist learning theories**—Prominent theories include social activism (Dewey), social learning (Bandura), scaffolding (Vygotsky), child development (Piaget), discovery learning (Bruner), and multiple intelligences (Gardner) theories. Constructivist integration strategies call for solving problems in settings that are familiar and meaningful to students; they often focus on having students use data-gathering tools to study problems and issues in their locale, on creating multimedia products to present their new knowledge and insights, on immersing oneself in simulated inquiry-based environments, and on communicating with others around the globe.
4. **Contrasting technology integration strategies based on theories**—Directed integration strategies aim to remedy identified weaknesses or skill deficits; to promote skill fluency or automaticity; to support efficient, self-paced learning; and to support self-paced review of concepts. Constructivist integration strategies aim to foster creative problem solving and metacognition; to help build mental models and increase knowledge transfer; to integrate and foster group cooperation skills; and to integrate allowing for multiple and distributed intelligences. Integration strategies common to both directed and constructivist models include generating motivation to learn, optimizing scarce resources, removing logistical hurdles to learning, and developing digital citizenship.
5. **The Turn-around Technology Integration Pedagogy and Planning (TTIPP) Model**—This model is designed

to help teachers plan for successful and transformative classroom uses of technology. The model consists of nine steps within three phases:

Phase 1: Analysis of Learning and Teaching Assets and Needs

Phase 2: Design of the Integration Framework

Phase 3: Post-Instruction Analysis and Revisions

Technology Integration Workshop

1. Apply What You Learned

You have read in this chapter how technology integration activities vary according to directed and constructivist views of learning and pedagogy and can replace, amplify, or transform aspects of instruction, learning, or curriculum. Now apply your understanding of these concepts by doing the following activities:

- Reread Mr. Ng and Ms. Rodriguez's lessons in Technology Integration in Action: *The Role of Learning Theory* at the beginning of the chapter. Reflect on each lesson's approach to teaching and learning and determine which one reflects a directed or a constructivist approach. Identify how the respective theories underlie the practices in the lessons (see Figures 2.2 and 2.3 for assistance).
- Review how Ms. Mian RATified her lesson in the Technology Integration Example 2.2. Now, try using the **RAT Matrix** to analyze the role technology played in Mr. Ng and Ms. Rodriguez's lessons described in Technology Integration in Action: *The Role of Learning Theory* at the beginning of the chapter. Reflect on the role technology plays as replacement, amplification, and/or transformation of instruction, student learning, and/or curriculum. Do you feel that the ways technology was integrated provided relative advantage?

2. Technology Integration Lesson Planning: Evaluating Lesson Plans

Complete the following exercise using sample lesson plans found on the web or provided by your instructor.

a. Locate technology-supported lessons—Identify three lesson plans that focus on any of the strategies you learned about in this chapter. For example, select those that reflect:
- Directed integration strategies
- Constructivist integration strategies
- Integration strategies useful to support either directed or constructivist approaches

b. Evaluate the lessons—Use the Technology Lesson Plan Evaluation Checklist and the RAT Matrix to evaluate each of the lessons you found. Based on the evaluation and your RATification of the lessons, would you adopt these lessons in the future? Why or why not?

3. Technology Integration Lesson Planning: Creating Lesson Plans with the TTIPP Model

Review how to implement the TTIPP Model (see Figure 2.6) for technology integration planning. Create your own technology-supported lesson by doing the following:

a. Describe Phase 1—Analysis of Learning and Teaching Assets and Needs:
- What is the problem of practice or main content topic in your lesson?
- What are the technology resources that your students, their families, you, and your school could bring as assets for the lesson?
- What are the technological possibilities for helping to solve the identified problem of practice? Identify the technology(ies) you will integrate into the lesson and ensure that you have skills and resources you need to carry it out.

b. Describe Phase 2—Design of the Integration Framework:
- What are the objectives of the lesson plan?
- How will you assess your students' accomplishment of the objectives?
- What integration strategies are used in this lesson plan?
- What is the relative advantage of using the technology(ies) in this lesson?
- How would you prepare the learning environment?

c. Describe Phase 3—Post-instruction Analysis and Revisions:
- What strategies and/or instruments would you use to evaluate the success of this lesson in your classroom in order to determine revision needs?
- Add lesson descriptors—Create descriptors for your new lesson (e.g., grade level, content and topic areas, technologies used, ISTE standards, 21st-Century Learning standards).
- Save and share your new lesson—Save your lesson plan with all its descriptors and TTIPP Model notes and share it with your peers, teacher, and others.

When you use your new lesson with students, be sure to assess it using the Technology Impact Checklist.