Goal of Technology Integrations: Meaningful Learning

CHAPTER 1


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Chapter Objectives

1. Identify the characteristics of meaningful learning
2. Contrast learning from technology and learning with technology
3. Compare National Educational Technology Standards (NETS) for students with teacher activities that foster them
4. Describe how technology can foster 21st Century Skills
5. Describe the components of technological pedagogical content knowledge

This edition of *Meaningful Learning with Technology* is one of many books describing how technologies can and should be used in schools. What distinguishes this book from the others is our focus on learning, especially meaningful learning. Most of the other books are organized by technology. They provide advice on how to use technologies, but often the purpose for using those technologies is not explicated.

Meaningful Learning with Technology, on the other hand, is organized by kinds of learning. What drives learning, more than anything else, is understanding and persisting on some task or activity. The nature of the tasks best determines the nature of the students' learning. Unfortunately, the nature of the tasks that so many students most commonly experience in schools is completing standardized tests or memorizing information for teacher-constructed tests. Schools in the United States have become testing factories. Federal legislation (No Child Left Behind) has mandated continuous testing of K–12 students in order to make schools and students more accountable for their learning. In order to avoid censure and loss of funding, many K–12 schools have adopted test preparation as their primary curriculum. Perhaps the most unfortunate phenomenon of this process is the current generation of students who will complete their K–12 education knowing only how to take tests. Because the purpose of those tests is administrative, students are seldom fully invested in the process so they make little attempt to understand the knowledge being tested. The students do not ask to take the tests. The tests assess skills and knowledge that are detached from their everyday experience, so they have little meaning. The testing process is individual, so students are prevented from cooperating with others. The tests represent only a single form of knowledge representation, so students are not able to develop conceptual understanding, which requires representing what you know in multiple ways. Simply stated, learning to take tests does not result in meaningful learning.

In order for students to learn meaningfully, they must be willfully engaged in a meaningful task. In order for meaningful learning to occur, the task that students pursue should engage active, constructive, intentional, authentic, and cooperative activities. Rather than testing inert knowledge, schools should help students to learn how to recognize and solve problems, comprehend new phenomena, construct mental models of those phenomena, and, given a new situation, set goals and regulate their own learning (learn how to learn). In order to help students accomplish those goals, we have organized the book around meaningful learning activities, not technologies.

- Inquiring with Technologies—Information gathering and literacy
- Experimenting with Technologies—Predicting outcomes
- Designing with Technologies—Creative knowledge construction
- Communicating with Technologies—Meaningful discourse
- Community Building and Collaborating with Technologies—Social interactions and identity building
- Writing with Technologies—Constructing meaningful prose
- Modeling with Technologies—Building models for conceptual change
- Visualizing with Technologies—Constructing visual representations

- Assessing Meaningful Learning and Teaching with Technologies—Resources for assessment, for both teachers and students

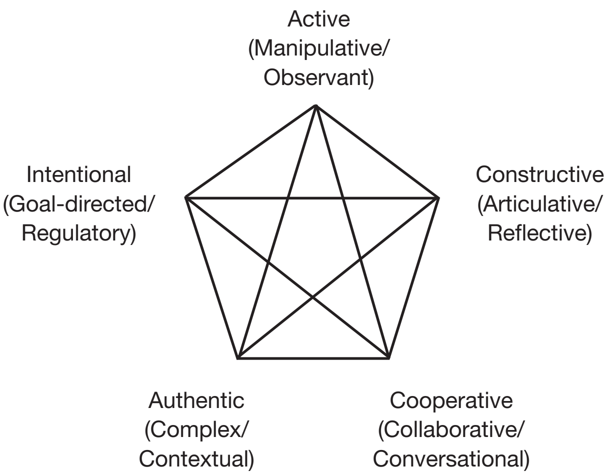
Those tasks are meaningful when they require intentional, active, constructive, cooperative, and authentic learning (see Figure 1.1). These attributes of meaningful learning are emphasized throughout the book as the goals for using technologies as well as the criteria for evaluating the uses of technology. Let's examine these attributes a little more closely.

- **Active (Manipulative/Observant)** Learning is a natural, adaptive human process. Humans have survived and therefore evolved because they were able to learn about and adapt to their environment. Humans of all ages, without the intervention of formal instruction, have developed sophisticated skills and advanced knowledge about the world around them when they need to or want to. When learning about things in natural contexts, humans interact with their environment and manipulate the objects in that environment, observing the effects of their interventions and constructing their own interpretations of the phenomena and the results of their manipulations. For instance, before playing sandlot baseball, do kids subject themselves to lectures and multiple-choice examinations about the theory of games, the aerodynamics of orbs, and vector forces applied to them? No! They start swinging the bat and chasing fly balls, and they negotiate the rules as they play the game. Through formal and informal apprenticeships in communities of play and work, learners develop skills and knowledge that they then share with other members of those communities with whom they learned and practiced those skills. In all of these situations, learners are actively manipulating the objects and tools of the trade and observing the effects of what they have done. The batter who consistently hits foul balls will adjust his or her stance and grip on the bat in order to manipulate the ball's path of flight and observe the effects of each manipulation. Meaningful learning requires learners who are active—actively engaged by a meaningful task in which they manipulate objects and parameters of the environment they are working in and observing the results of their manipulations.

- **Constructive (Articulative/ Reflective)** Activity is necessary but not sufficient for meaningful learning. It is essential that learners articulate what they have accomplished and reflect on their activity and observations—to learn the lessons that their activity has to teach. New experiences often provide a discrepancy between what learners observe

Figure 1.1

Characteristics of Meaningful Learning



and what they understand. That is when meaningful learning begins. They are curious about or puzzled by what they see. That puzzlement is the catalyst for meaning making. By reflecting on the puzzling experience, learners integrate their new experiences with their prior knowledge about the world, or they establish goals for what they need to learn in order to make sense out of what they observe. Learners begin constructing their own simple mental models that explain what they observe, and with experience, support, and more reflection, their mental models become increasingly complex. Ever more complex models require that learners mentally represent their understanding in different ways using different thought processes. The active and constructive parts of the meaning-making process are symbiotic.

- **Intentional (Goal-Directed/Regulatory)** All human behavior is goal directed (Schank, 1994). That is, everything that we do is to fulfill some goal. That goal may be simple, like satiating hunger or getting more comfortable, or it may be more complex, like developing new career skills or studying for a master's degree. When learners are actively and willfully trying to achieve a cognitive goal (Scardamalia & Bereiter, 1993/1994), they think and learn more because they are fulfilling an intention. Technologies have traditionally been used to support teachers' goals, but not those of learners. Technologies need to engage learners in articulating and representing their understanding, not the teachers'. When learners use technologies to represent their actions and construction, they understand more and are better able to use the knowledge that they have constructed in new situations. When learners use computers to do skillful planning for doing everyday tasks or constructing and executing a way to research a problem they want to solve, they are intentional and are learning meaningfully.

- **Authentic (Complex/Contextual)** Most lessons taught in schools focus on general principles or theories that may be used to explain phenomena that we experience. However, teachers and professors remove those ideas from their natural contexts in order to be able to cover the curriculum more efficiently. When they do, they strip those principles of the contextual cues that make them meaningful. Physics courses are a prime example. Teachers read a simplified problem and immediately represent the problem in a formula. Students may learn to get the correct answer, but what are they learning? The students learned to understand the ideas only as algorithmic procedures outside of any context, so they have no idea how to apply the ideas to real-world contexts. Everything physical that occurs in the world involves physics. Why not learn physics through baseball, driving, walking, or virtually any other physical process on earth?

  Most contemporary research on learning has shown that learning tasks that are situated in some meaningful real-world task or simulated in some case-based or problem-based learning environment are not only better understood and remembered, but also are more consistently transferred to new situations. Rather than abstracting ideas in rules that are memorized and then applied to other canned problems, learning should be embedded in real life, useful contexts for learners to practice using those ideas.

- **Cooperative (Collaborative/Conversational)** Humans naturally work together in learning and knowledge-building communities, exploiting each others' skills and appropriating each others' knowledge in order to solve problems and perform tasks. So, why do educators insist that learners work independently so much of the time? Schools generally function based on the belief that learning is an independent process, so learners seldom have the opportunity to "do anything that counts" in collaborative teams despite their natural inclinations. When students collaborate without permission, educators may even accuse them of cheating despite the fact that such cross-fertilization is encouraged in any self-respecting design studio. However, we believe that relying solely on independent methods of instruction cheats learners out of more natural and productive modes of thinking. Often, educators will promote collaborative methods of learning, only to resort to independent assessment of learning. Learners, they believe, must be accountable for their own knowledge, so even if you agree, at least in principle, with collaborative learning principles, the hardest part of applying your beliefs will be assessing learners in teams. Most of the technology-based activities described throughout this book are more effectively performed collaboratively in groups, so we must assess the performance of the groups, as well as individuals. Learners are strategic enough to know "what counts" in classrooms, so if they are evaluated individually, collaborative learning activities will fail because students realize that their outcomes are not important.

Collaboration most often requires conversation among participants. Learners working in groups must socially negotiate a common understanding of the task and the methods they will use to accomplish it. That is, given a problem or task, people naturally seek out opinions and ideas from others. Technologies can support this conversational process by connecting learners in the same classroom, across town, or around the world (see Chapters 6 and 7). When learners become part of knowledge-building communities both in class and outside of school, they learn that there is more than one way to view the world and there are multiple solutions to most of life's problems. Conversation should be encouraged because it is the most natural way of making meaning.

As is depicted in Figure 1.1, these characteristics of meaningful learning are interrelated, interactive, and interdependent. That is, learning and instructional activities should engage and support combinations of active, constructive, intentional, authentic, and cooperative learning. Why? Because we believe that these characteristics are synergetic. That is, learning activities that represent a combination of these characteristics result in even more meaningful learning than the individual characteristics would in isolation.

There are many kinds of learning activities that engage meaningful learning, just as there are teachers who for years have engaged students in meaningful learning. We argue throughout this book that technologies can and should become the tools of meaningful learning. Technologies afford students the opportunities to engage in meaningful learning when they learn *with* the technology, not *from* it.

How Does Technology Facilitate Meaningful Learning?

Learning *from* Technology

Some of the first educational technologies were illustrations in 17th-century books and slate chalkboards in 18th-century classrooms. Educational technologies in the 20th century included lantern-slide and opaque projectors, later radio, and then motion pictures.

During the 1950s, programmed instruction emerged as the first true educational technology, that is, the first technology developed specifically to meet educational needs. With every other technology, including computers, educators recognized its importance and debated how to apply each nascent commercial technology for educational purposes. Unfortunately, educators have almost always tried to use technologies to teach students in the same ways that teachers had always taught. So information was recorded in the technology (e.g., the content presented by films and television programs), and the technology presented that information to the students. The effectiveness of each technology has been determined by how effectively it communicates ideas to students. The students' role was to learn the information presented by the technology, just as they learned information presented by the teacher. The role of the technology was to deliver lessons to students, just as trucks deliver groceries to supermarkets (Clark, 1983). If you deliver groceries, people will eat. If you deliver instruction, students will learn, right? Not necessarily! We will tell you why later.

The introduction of modern computer technologies in classrooms has followed the same pattern of use. Before the advent of microcomputers in the 1980s, mainframe computers were used to deliver drill and practice and simple tutorials for teaching students lessons. When microcomputers began populating classrooms, the natural inclination was to use them in the same way. A 1983 national survey of computer use showed that drill and practice was the most common use of microcomputers (Becker, 1985).

Later in the 1980s, educators began to perceive the importance of computers as productivity *tools*. The growing popularity of word processing, databases, spreadsheets, graphics programs, and desktop publishing was enabling businesses to become more productive. So students in the classroom began word processing and using graphics packages and desktop publishing programs to write with (see Chapter 4). This tool conception pervaded computer use according to a 1993 study by Hadley and Sheingold that showed that well-informed teachers were extensively using text-processing tools (word processors), analytic and information tools (especially databases and some spreadsheet use), and graphics tools (paint programs and desktop publishing) along with instructional software (including problem-solving programs along with drill and practice and tutorials).

The development of inexpensive multimedia computers and the eruption of the Internet in the mid-1990s quickly changed the nature of educational computing. Communications tools (e-mail and computer conferences) and multimedia, little used according to Hadley and Sheingold, have dominated the role of technologies in the classroom ever since. Now, Web 2.0 is more rapidly changing the landscape of educational computing. According to Schrum and Levin (2009), Web 2.0 is more distributed, collaborative, open source, and free, with more shared content produced by multiple users than Web 1.0. But what are the students producing? Too often, they are using the technology to reproduce what the teacher or textbook told them or what they copy from the Internet.

Our conception of educational computing and technology use, described next, is that technologies are not just repositories and distributors of information but rather tools. We believe that students should use the technology to represent what they know rather than reproducing what teachers and textbooks tell them. Technologies provide rich and flexible media that students can use to communicate their ideas with other students in collaborative groups. A great deal of research on computers and other technologies has shown that technologies are no more effective at teaching students than teachers, but if we begin to think about technologies as learning tools that students learn *with*, not *from*, then the nature of student learning will change.

Learning *with* Technology?

If schools are to foster meaningful learning, then the ways that technologies are used in schools must change from technology-as-teacher to technology-as-partner in the learning process. Before, the authors argued that students do not learn from technology but that technologies can support productive thinking and meaning making by students. That will happen when students learn *with* the technology. But, how is that done? How can technologies become intellectual partners with students? Throughout this book, the authors assume that:

- Technology is more than hardware. Technology consists also of the designs and the environments that engage learners. Technology can also consist of any reliable technique or method for engaging learning, such as cognitive-learning strategies and critical-thinking skills.
- Learning technologies can be any environment or definable set of activities that engage learners in active, constructive, intentional, authentic, and cooperative learning.
- Technologies are not conveyors or communicators of meaning. Nor should they prescribe and control all of the learner interactions.
- Technologies support meaningful learning when they fulfill a learning need—when interactions with technologies are learner initiated and learner controlled, and when interactions with the technologies are conceptually and intellectually engaging.
- Technologies should function as intellectual tool kits that enable learners to build more meaningful personal interpretations and representations of the world. These tool kits must support the intellectual functions that are required by a course of study.
- Learners and technologies should be intellectual partners, where the cognitive responsibility for performance is distributed to the partner that performs it better.

How Technologies Foster Learning

If technologies are used to foster meaningful learning, then they will not be used as delivery vehicles. Rather, technologies should be used as engagers and facilitators of thinking. Based on our conception of meaningful learning (Figure 1.1), we suggest the following roles for technologies in supporting meaningful learning:

- Technology as tools to support knowledge construction:
  - for representing learners' ideas, understandings, and beliefs
  - for producing organized, multimedia knowledge bases by learners
- Technology as information vehicle for exploring knowledge to support learning by constructing:
  - for accessing needed information
  - for comparing perspectives, beliefs, and worldviews

- Technology as authentic context to support learning by doing:
  - for representing and simulating meaningful real-world problems, situations, and contexts
  - for representing beliefs, perspectives, arguments, and stories of others
  - for defining a safe, controllable problem space for student thinking
- Technology as social medium to support learning by conversing:
  - for collaborating with others
  - for discussing, arguing, and building consensus among members of a community
  - for supporting discourse among knowledge-building communities
- Technology as intellectual partner (Jonassen, 2000a) to support learning by reflecting:
  - for helping learners to articulate and represent what they know
  - for reflecting on what they have learned and how they came to know it
  - for supporting learners' internal negotiations and meaning making
  - for constructing personal representations of meaning
  - for supporting mindful thinking

Alternative Conceptions of Meaningful Technology Use

Several organizations have worked to develop conceptions and standards for meaningful learning with technology. Here, the International Society for Technology in Education (ISTE) standards, Partnership for 21st Century Skills, and Technological Pedagogical Content Knowledge (TPACK) are presented and discussed.

ISTE NET Standards

The ISTE (www.iste.org) published a new set of National Educational Technology Standards (NETS) in 2007. Table 1.1 lists the standards for students and for teachers. They also published standards for administrators, but those are beyond the scope of this book.

The NETS provide a challenging set of expectations for students and teachers that, if fulfilled, could change the nature of education in our schools. They emphasize knowledge construction, collaboration, and critical thinking that are congruent with the 21st Century Skills that are described next. Although they can be interpreted in many ways, students and teachers who choose to achieve those standards should certainly find useful suggestions from this book, as well as the professional development materials and activities provided by ISTE.

21st Century Skills

The Partnership for 21st Century Skills is a national organization that advocates for 21st-century readiness for every student. As the United States continues to compete in a global economy that demands innovation, P21 and its members provide tools and resources to help the U.S. education system keep up by fusing the three Rs and four Cs (critical thinking and problem solving, communication, collaboration, and creativity and innovation). The

Table 1.1 ISTE's National Educational Technology Standards (NETS)

NETS—Students	NETS—Teachers
1. Creativity and Innovation a. apply existing knowledge to generate new ideas, products, or processes b. create original works as a means of personal or group expression c. use models and simulations to explore complex systems and issues d. identify trends and forecast possibilities	**1. Facilitate and Inspire Student Learning and Creativity** a. promote, support, and model creative and innovative thinking and inventiveness b. engage students in exploring real-world issues and solving authentic problems using digital tools and resources c. promote student reflection using collaborative tools to reveal and clarify students' conceptual understanding and thinking, planning, and creative processes d. model collaborative knowledge construction by engaging in learning with students, colleagues, and others in face-to-face and virtual environments
2. Communication and Collaboration a. interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media b. communicate information and ideas effectively to multiple audiences using a variety of media and formats c. develop cultural understanding and global awareness by engaging with learners of other cultures d. contribute to project teams to produce original works or solve problems	**2. Design and Develop Digital-Age Learning Experiences and Assessments** a. design or adapt relevant learning experiences that incorporate digital tools and resources to promote student learning and creativity b. develop technology-enriched learning environments that enable all students to pursue their individual curiosities and become active participants in setting their own educational goals, managing their own learning, and assessing their own progress c. customize and personalize learning activities to address students' diverse learning styles, working strategies, and abilities using digital tools and resources d. provide students with multiple and varied formative and summative assessments aligned with content and technology standards and use resulting data to inform learning and teaching
3. Research and Information Fluency a. plan strategies to guide inquiry b. locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media c. evaluate and select information sources and digital tools based on the appropriateness to specific tasks d. process data and report results	**3. Model Digital-Age Work and Learning** a. demonstrate fluency in technology systems and the transfer of current knowledge to new technologies and situations b. collaborate with students, peers, parents, and community members using digital tools and resources to support student success and innovation c. communicate relevant information and ideas effectively to students, parents, and peers using a variety of digital-age media and formats d. model and facilitate effective use of current and emerging digital tools to locate, analyze, evaluate, and use information resources to support research and learning

(*continued*)

Table 1.1 ISTE's National Educational Technology Standards (NETS) (*continued*)

NETS—Students	NETS—Teachers
4. Critical Thinking, Problem Solving, and Decision Making a. identify and define authentic problems and significant questions for investigation b. plan and manage activities to develop a solution or complete a project c. collect and analyze data to identify solutions and/or make informed decisions d. use multiple processes and diverse perspectives to explore alternative solutions	**4. Promote and Model Digital Citizenship and Responsibility** a. advocate, model, and teach safe, legal, and ethical use of digital information and technology, including respect for copyright, intellectual property, and the appropriate documentation of sources b. address the diverse needs of all learners by using learner-centered strategies and providing equitable access to appropriate digital tools and resources c. promote and model digital etiquette and responsible social interactions related to the use of technology and information d. develop and model cultural understanding and global awareness by engaging with colleagues and students of other cultures using digital-age communication and collaboration tools
5. Digital Citizenship a. advocate and practice safe, legal, and responsible use of information and technology b. exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity c. demonstrate personal responsibility for lifelong learning d. exhibit leadership for digital citizenship	**5. Engage in Professional Growth and Leadership** a. participate in local and global learning communities to explore creative applications of technology to improve student learning b. exhibit leadership by demonstrating a vision of technology infusion, participating in shared decision making and community building, and developing the leadership and technology skills of others c. evaluate and reflect on current research and professional practice on a regular basis to make effective use of existing and emerging digital tools and resources in support of student learning d. contribute to the effectiveness, vitality, and self-renewal of the teaching profession and of their school and community
6. Technology Operations and Concepts a. understand and use technology systems b. select and use applications effectively and productively c. troubleshoot systems and applications d. transfer current knowledge to learning of new technologies	

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Partnership for 21st Century Skills (www.p21.org) has articulated a set of skills needed by 21st-century graduates (Figure 1.2). The key elements of 21st-century learning are represented in the graphic and descriptions that follow. The 21st Century Skills student outcomes are illustrated in the arches of the rainbow. Those skills include life and career skills (beyond the scope of this book) and learning and innovation skills and information literacy skills, which are the focus of this book. The core subject skills are discipline specific. They may be enhanced by students' learning and innovation skills and information literacy skills. Table 1.2 lists elements of the framework and shows the classes of Learning and Innovation Skills.

Although open to interpretation, this set of skills describes the abilities possessed by ideal students who are able to function independently and collaboratively in schools. The degree to which technologies can support development of these skills in students may determine whether we are able to change the culture of education in this country.

Technological Pedagogical Learning Content Knowledge

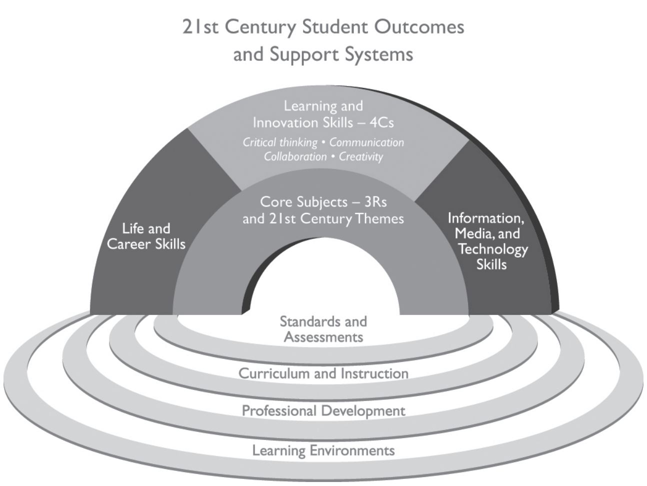
Koehler and Mishra (2009) and Mishra and Koehler (2006) articulated a model of Technological Pedagogical Content Knowledge (TPACK) that focused on what teachers ought to know about integrating technology in their instruction. We, however, believe that it does not go far enough. But first, what is the source of this issue? Prior to their work, educational researchers have been concerned with what teachers ought to know about teaching. This movement began with Lee Shulman's (1986, 1987) conception of pedagogical content knowledge (PCK). Shulman assumed that, in order to be effective, teachers should possess pedagogical content knowledge. Pedagogical content knowledge includes the conceptual union of content knowledge and pedagogical knowledge.

Content knowledge describes a teacher's knowledge of the subject matter content that he or she teaches. Most educators assume that the more you know about the discipline that you teach, the better teacher you will be. Well-developed content knowledge seems essential to the ability to convey accepted information to students in order to avoid the acquisition of misconceptions by students.

Shulman rightly believed that content knowledge alone is not sufficient for being a good teacher. He argued that teachers also need pedagogical knowledge. Pedagogical knowledge describes a teacher's knowledge of the activities of instructing or teaching, including those teaching behaviors that impart knowledge or skill. Although some conceptions of pedagogy include

Figure 1.2

Framework for 21st Century Learning



Source: Courtesy of the Partnership for 21st Century Skills.

Table 1.2 Elements of the 21st Century Skills Framework

Learning and Innovation Skills

Creativity and Innovation Skills

Think Creatively

- Use a wide range of idea-creation techniques (such as brainstorming)
- Create new and worthwhile ideas (both incremental and radical concepts)
- Elaborate, refine, analyze, and evaluate their own ideas in order to improve and maximize creative efforts

Work Creatively with Others

- Develop, implement, and communicate new ideas to others effectively
- Be open and responsive to new and diverse perspectives; incorporate group input and feedback into the work
- Demonstrate originality and inventiveness in work and understand the real-world limits to adopting new ideas
- View failure as an opportunity to learn; understand that creativity and innovation is a long-term, cyclical process of small successes and frequent mistakes

Implement Innovations

- Act on creative ideas to make a tangible and useful contribution to the field in which the innovation will occur

Critical Thinking and Problem Solving

Reason Effectively

- Use various types of reasoning (inductive, deductive, etc.) as appropriate to the situation

Use Systems Thinking

- Analyze how parts of a whole interact with each other to produce overall outcomes in complex systems

Make Judgments and Decisions

- Effectively analyze and evaluate evidence, arguments, claims, and beliefs
- Analyze and evaluate major alternative points of view
- Synthesize and make connections between information and arguments
- Interpret information and draw conclusions based on the best analysis
- Reflect critically on learning experiences and processes

Solve Problems

- Solve different kinds of nonfamiliar problems in both conventional and innovative ways
- Identify and ask significant questions that clarify various points of view and lead to better solutions

Communication and Collaboration Skills

Communicate Clearly

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade)
- Utilize multiple media and technologies, and know how to judge their effectiveness a priori as well as assess their impact
- Communicate effectively in diverse environments (including multilingual)

Collaborate with Others

- Demonstrate ability to work effectively and respectfully with diverse teams
- Exercise flexibility and willingness to be helpful in making necessary compromises to accomplish a common goal
- Assume shared responsibility for collaborative work, and value the individual contributions made by each team member

Information, Media, and Technology Skills

Information Literacy

Access and Evaluate Information

- Access information efficiently (time) and effectively (sources)
- Evaluate information critically and competently

Use and Manage Information

- Use information accurately and creatively for the issue or problem at hand
- Manage the flow of information from a wide variety of sources
- Apply a fundamental understanding of the ethical/legal issues surrounding the access and use of information

Media Literacy

Analyze Media

- Understand both how and why media messages are constructed, and for what purposes
- Examine how individuals interpret messages differently, how values and points of view are included or excluded, and how media can influence beliefs and behaviors
- Apply a fundamental understanding of the ethical/legal issues surrounding the access and use of media

Create Media Products

- Understand and utilize the most appropriate media creation tools, characteristics, and conventions
- Understand and effectively utilize the most appropriate expressions and interpretations in diverse, multicultural environments

ICT Literacy

Apply Technology Effectively

- Use technology as a tool to research, organize, evaluate, and communicate information
- Use digital technologies (computers, PDAs, media players, GPS, etc.), communication/networking tools and social networks appropriately to access, manage, integrate, evaluate, and create information to successfully function in a knowledge economy
- Apply a fundamental understanding of the ethical/legal issues surrounding the access and use of information technologies

Courtesy of the Partnership for 21st Century Skills.

understanding how students learn and how to assess student understanding, pedagogy is more commonly associated with acts of teaching, not learning.

While Shulman's conceptions of teacher knowledge make a great deal of sense, we believe that there are some fundamental problems with the concepts of content knowledge and pedagogical knowledge: the epistemological assumptions, the nature of knowledge, and the importance of learning.

First, we consider the epistemology of content knowledge. Epistemology is the philosophy of knowledge: what it means to know, how we develop knowledge, and what is truth.

When educators speak of content, it is assumed that the content exists in objective reality. Content is the stuff that we should learn. Content is the stuff that teachers deliver to students. If content can be delivered, then it must exist in some objective form. From a constructivist epistemological framework, knowledge is constructed individually and socially based on students' interactions with the world and each other. Knowledge cannot be delivered. Information can. When a teacher tells students what she or he knows, too often the teacher assumes that students will know it just like the teachers, that is, that the teacher has transferred knowledge to the students. That is impossible for a book full of reasons.

We also argue that content knowledge is a somewhat impoverished concept, because it does not articulate *how* teachers should know, only *what* they should know. Teachers and professors often experience difficulties in teaching because the knowledge of content that they have constructed is fragile and underdeveloped. Teachers and professors whose knowledge is exclusively based on textbooks and lectures cannot know content as well as an experienced practitioner who has constructed knowledge by using it. Also, content knowledge does not distinguish among the many kinds of knowledge, that is, how teachers should know. There are many kinds of knowledge that are constructed based on different kinds of activities and interactions. Jonassen (2009) identified numerous kinds of knowledge that can be constructed, including:

- *Declarative knowledge:* The most common kind when "knowledge" is delivered
- *Structural knowledge:* The knowledge of the propositional relationships among concepts
- *Conceptual knowledge:* The knowledge of frameworks that support conceptual change
- *Procedural knowledge:* The knowledge of how to perform some process
- *Situational knowledge:* The knowledge of contextual situations
- *Strategic knowledge:* The knowledge of when and why to perform some process
- *Tacit knowledge:* The knowledge that we know but cannot express
- *Sociocultural knowledge:* The knowledge of one's worldview, belief systems, attitudes, and socially shared knowledge among a culture of people
- *Experiential (episodic) knowledge:* The knowledge of the stories about our experiences

There are numerous other kinds of knowledge that have been conceived. Which kinds of knowledge should students learn? Clearly, the nature of the instruction will determine to a large degree the kinds of knowledge that students construct. It should also be obvious that pedagogical knowledge is not monolithic. Rather, it must articulate the numerous kinds of knowledge required to effectively teach students. Because the goal of pedagogy is, or at least should be, learning, a deeper understanding of learning is essential for developing any understanding of teaching. Therefore, we would like content knowledge to be conceived as disciplinary knowledge, where the different kinds of knowledge common to various disciplines could be articulated. That would provide a much clearer goal for constructing pedagogical knowledge (how to teach those different kinds of disciplinary knowledge).

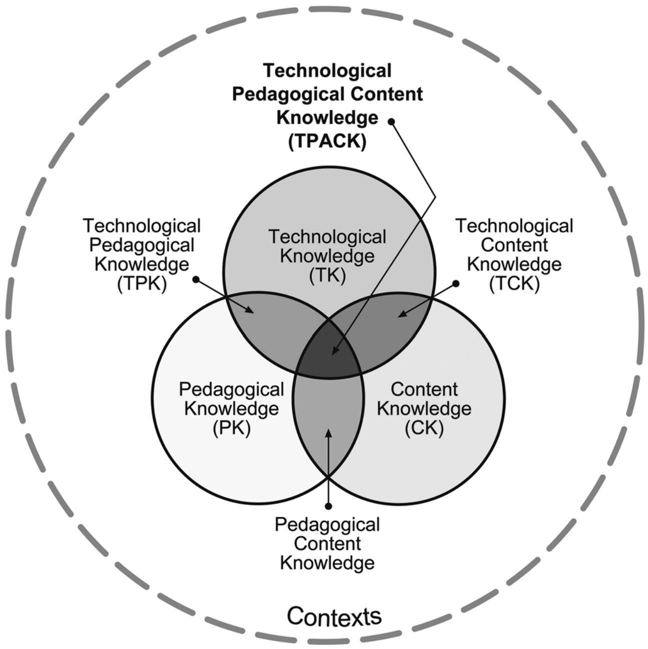
Articulating the kinds of knowledge that students can construct about the discipline (content) they are studying brings up perhaps the most important issue related to pedagogical content knowledge: learning. Although some conceptions of pedagogical knowledge include the teacher's understanding of how students learn, pedagogy mostly refers to how teachers teach. We argue that pedagogical content knowledge needs another dimension: learning knowledge. There are many more alternative conceptions of learning than there are concepts of knowledge. Learning theory courses are replete with alternative conceptions of how people learn, each of which is based on different philosophies and relies on different pedagogies. For each theory, there are numerous ways of thinking (far too many to review here). Suffice it to say that the most common kind of thinking required of students is recall. In order to engage students in deeper-level, more meaningful learning, students must learn how to perform analogical reasoning (comparing ideas structurally), causal reasoning (predictions, inferences, and implications), conceptual model building, argumentation (rhetorical and dialectic), and metacognitive reasoning (Jonassen, 2011). Understanding how students learn meaningfully is essential to teaching. The challenge of that assumption is tough: If you as a teacher are unable to articulate how your students need to think in order to learn what you want them to learn, how can you know what or how or why to teach?

Koehler and Mishra (2009) and Mishra and Koehler (2006) have added to PCK what teachers ought to know about integrating technology in their instruction. This newer component argues that good teaching requires knowledge of content, pedagogy, and technology. Ergo, they argue for the importance of TPACK, the union of those three kinds of knowledge (see Figure 1.3). Technological pedagogical content knowledge (TPACK) is the knowledge of how technologies can best be employed in different pedagogies for facilitating the acquisition of content knowledge. To their credit, Koehler and Mishra have focused on the affordances of each technology for teaching content. What kinds of activities do technologies afford (support or enable)? For example, e-mail affords the asynchronous exchange and storage of interpersonal messages. Unfortunately, e-mail does not afford synchronous exchanges or nonverbal aspects of communication, such as tone, mood, or expressiveness. Focusing on affordances is a very useful framework for examining educational technologies. Perhaps the most important ideas from the model in Figure 1.3 are the interactions among these kinds of knowledge, including pedagogical content knowledge, technological content knowledge, and technological pedagogical knowledge.

Notwithstanding our previously expressed concerns about pedagogical and content knowledge, one can also argue that teaching with technology is merely another kind of pedagogy and therefore an unnecessary dimension. For purposes of this book, however, we must accept the importance of learning with technologies (the primary topic and title of this book). However, if we accept technology knowledge as an essential kind of knowledge for teachers, then we also argue that we should also include a learning knowledge dimension, which would expand TPACK into TPLACK. We believe that it is impossible to make meaningful recommendations about technology use without a clear conception of how students are supposed to learn. Too often, technologies are implemented for their own sake. If you use technologies, they will learn (maybe). TPLACK decisions would then focus on which technology engages the particular kinds of thinking and learning about aspects of different disciplines employing a particular pedagogy. For example, if I want my biology students to construct structural knowledge of different phyla, then I might recommend having students use a constructive pedagogy by building concept maps. An obvious complaint about TPLACK will be that it is too complicated. Perhaps, but design is complex. It is not nearly as

Figure 1.3

Technological Pedagogical Content Knowledge (TPACK)



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formulaic as many texts describe. Design is the most complex and ill-structured kind of problem that teachers must solve (Jonassen, 2000b). PCK, TPACK, and TPLACK are all about design decision making. That is an essential part of the job of teaching. The assumption underlying this book is that the most important factor in deciding what and how you should teach is what and how your students should learn. That is the major difference between this book and so many other teaching with technology textbooks.

Conclusion

An underlying assumption of this book is that the most productive and meaningful uses of technology will not occur if technologies are used in traditional ways: as delivery vehicles for instructional lessons. Technology cannot teach students. Rather, students learn as they use technology. Meaningful learning will result when technologies engage learners in:

- knowledge construction, not reproduction;
- conversation, not reception;
- articulation, not repetition;

- collaboration, not competition; and
- reflection, not prescription.

We argue that technologies can support meaningful learning when students learn through the use of the technology, not from it. When students use technologies to inquire (Chapter 2), experiment (Chapter 3), design (Chapter 4), communicate with others (Chapter 5), build communities (Chapter 6), write (Chapter 7), build models (Chapter 8), and visualize (Chapter 9), then they are engaged in deeper levels of thinking and reasoning, including causal, analogical, expressive, experiential, and problem solving. Technologies are lousy teachers, but they can be powerful tools to think with. That is the theme that we describe in the remainder of this book.

A caveat. Implementation of the values and beliefs underlying this book and all of the standards described in this chapter will represent a significant paradigm shift in education. Fostering that paradigm shift in education is a gigantic diffusion-and-adoption-of-change problem. Changing the beliefs of educators, students, parents, and communities will require enormous collaborations. Whether these beliefs are able to change the culture of testing and memorization in our schools remains to be seen. For the sake of our children and the next generation of leaders in our society, we truly hope so.

Things to Think About

If you would like to reflect on the ideas that we presented in this chapter, consider your responses to the following questions.

1. If learners cannot know what the teacher knows because they do not share a common knowledge and experience base, how can we be certain that students learn important things? For instance, if you want to teach students about the dangers of certain chemical reactions in the lab, how do we ensure that learners know and understand those important lessons?
2. What is your theory of learning? From your perspective, how do people learn? What are the important processes?
3. Which of the skills described in this chapter are most important to you as an educator? Which are most important to comprehending and being able to apply ideas in your discipline?
4. Is it possible to learn (construct personal meaning) without engaging in some activity; that is, is it possible to learn simply by thinking about something? Which technology-based activities will result in the most thinking and learning? Can you think of an example?
5. When learners construct knowledge, what are they building? How is it possible to observe the fruits of their labor, that is, the knowledge they construct? How can technologies help? Which technologies are most effective at representing what students know?
6. Think about a recent controversial topic that you have heard or read about. What are different sides arguing about? What do they believe? What assumptions do they make about what is causing the controversy? Where did those beliefs come from?

7. Radical constructivists argue that reality exists only in the mind of the knower. If that is true, is there a physical world that we live in? Prove it.
8. Some educators argue that we learn much more from our failures than from our successes. Why? They believe that we should put students in situations where their hypotheses or predictions fail. Can you think of a situation in which you learned a lot from a mistake?
9. Recall the last difficult problem that you had to solve. Did you solve it alone, or did you solicit the help of others? What did you learn from solving that problem? Can that learning be used again?
10. Can you learn to cook merely from watching cooking shows on television? What meaning do you make from the experiences that you observe? Will the experience that you have when you prepare a dish be the same as that of the television chef? How will it be different?
11. Technology is the application of scientific knowledge, according to many definitions. Can you think of a teaching technology (replicable, proven teaching process) that does not involve machines?
12. Can you calculate the exact square root of 2,570 without a calculator? Does the calculator make you smarter? Is the calculator intelligent?
13. Describe the difference in thinking processes engaged by a short answer versus a multiple-choice test question. Are they different? Are they assessing knowledge? Is that knowledge meaningful? Why or why not?
14. Can you think of an activity that makes you dumber, not smarter? Do you not learn anything from that activity?
15. Have you ever produced your own video, movie, slide show, or computer program? How did it make you think? How did it make you feel?

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