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# 1
# Introducing TPCK

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In this chapter we describe *technological pedagogical content knowledge* (TPCK) as a framework for teacher knowledge for technology integration (Mishra & Koehler, 2006). This framework builds on Shulman's construct of pedagogical content knowledge (PCK) to include technology knowledge. We argue that the development of TPCK by teachers is critical to effective teaching with technology. We emphasize teacher knowledge because we view the teacher as an autonomous agent with the power to significantly influence the appropriate (or inappropriate) integration of technology in teaching. In keeping with the goal of this volume (that of situating the idea of TPCK in the realm of teacher education and teacher professional development, and investigating how it differs by content areas) we explore the parameters of the TPCK framework within and between multiple curriculum areas, as well as in varying teaching and learning contexts.

We begin with a brief introduction to the complex, ill-structured nature of teaching. We consider the nature of technologies (both analog and digital), and how the inclusion of technology in pedagogy further complicates teaching. We propose to view teaching with technology as a "wicked problem" (Rittel & Webber, 1973), in which teaching is viewed as a highly complicated form of problem-seeking and problem-solving that derives from flexible and integrated bases of knowledge. We offer our TPCK framework for teacher knowledge in detail, as a complex interaction among three bodies of knowledge: *content*, *pedagogy*, and *technology*. We describe how these bodies of knowledge interact, in abstract, and in practice, to produce the type of flexible knowledge needed to successfully integrate technology in the classroom. Finally, we argue that the complexity of developing and applying TPCK suggests that a greater emphasis should be placed on the idea of teachers as "curriculum designers."

## Teaching as an ill-structured, complex domain

As Spiro and colleagues have argued, ill-structured domains are characterized by a complexity of concepts and cases with a wide variability of features across different cases (Spiro, Coulson, Feltovich, & Anderson, 1988; Spiro & Jehng, 1990). Like expertise in other complex domains including medical diagnosis (Lesgold, Feltovich, Glaser, & Wang, 1981; Pople, 1982), decision-making (Klein, 1999), and writing (Hayes & Flower, 1980; Hillocks, 1986), expertise in teaching is dependent on flexible access to and application of highly organized systems of knowledge (Glaser, 1984; Putnam & Borko, 2000; Shulman, 1986, 1987) that must continually shift and evolve based on the contexts within which they are applied. Teachers practice in a highly complex, dynamic environment (Leinhardt & Greeno, 1986; Spiro, Coulson, Feltovich, & Anderson, 1988; Spiro, Feltovich, Jacobson, & Coulson, 1991) that asks them to integrate knowledge of student thinking and learning, knowledge of the subject matter, and increasingly, knowledge of technology.

In this regard, teaching is akin to other real-world problems that are ill-structured, that lack required information, and do not have a known correct nor best solution (Frederiksen, 1986; Glass, Holyoak, & Santa, 1979; Nickerson, 1994; Reitman, 1964; Roberts, 1994). Other examples of ill-structured domains are biomedicine (Feltovich, Coulson, Spiro, & Dawson-Saunders, 1992), literary analysis (Jones & Spiro, 1992; Spiro & Jehng, 1990), and law (Feltovich, Spiro, Coulson, & Myers-Kelson, 1995; Lawrence, 1988; Williams, 1992). Paradoxically, domains that appear to be well-structured can also be ill-structured, either at advanced levels of study, or when applied to unconstrained, naturally occurring situations (Mishra, Spiro, & Feltovich, 1996; Mishra & Yadav, 2006; Spiro, Feltovich, Jacobson, & Coulson, 1991).

For example, mathematics is typically treated as a very structured field that is concerned with solving problems which have unique, correct answers, developed as the logical consequence of manipulations of a finite set of axioms or postulates. Professional mathematicians, however, hold a very different view of their field, and consider it laden with ambiguity and uncertainty (Davis & Hersh, 1981). Ill-structuredness also appears when abstract mathematical ideas are applied to real-world situations (Resnick, 1988). Similarly, physics appears to be an orderly and regular discipline—except when applied to the real world, as in the case of engineering. Building a bridge, for example, applies principles of physics, but the unique features of each case (including the cost, materials, and setting) prevent the indiscriminate generalization from one case to another (Guzdial, Turns, Rappin, & Carlson, 1995; Petroski, 1985, 1994).

Teaching, consistent with the examples above, is a classic example of an ill-structured discipline with a high level of variability across situations as well as a dense context-dependent inter-connectedness between knowledge and practice. As educators know, the application of knowledge in teaching involves many different conceptual structures and perspectives that play out in novel and unique ways even in instances that may seem superficially similar. The push to integrate technology in teaching further complicates matters by bringing an additional domain of knowledge (technology knowledge) into the mix.



It is important, therefore, that we develop a better understanding of what we mean by the term technology, particularly as it is applied in educational settings. The following sections explore this idea in greater detail.

## Understanding technology

We broadly define *technology* as the tools created by human knowledge of how to combine resources to produce desired products, to solve problems, fulfill needs, or satisfy wants (Wikipedia, 2006). This definition implies two uses of the word. The first use describes an individual tool or technique, and the second use encompasses all tools, techniques, and knowledge. If we choose to use the first sense of the term there can be an Internet technology that specifically refers to the tool we call the Internet. Likewise there is a "computer technology," a "word-processing technology," and "microscope technology" (collectively called *technologies*). Using the second sense of the term, there can be educational technology, which describes the sum of the tools, techniques, and collective knowledge applicable to education. This definition includes both analog technologies (e.g., chalkboard, pencil, and microscope) and digital technologies (e.g., the computer, blogging, and Internet). Our view does not distinguish between older technologies (e.g., the chalkboard, the overhead projector, the hand-held calculator, and the pencil) and newer technologies (e.g., the MP3 player and blogs).[2]

One of the most important things to understand about technologies is that *particular technologies have specific affordances and constraints*. Technologies are neither neutral nor unbiased; rather, particular technologies have their own propensities, biases, and inherent attributes that make them more suitable for certain tasks than others (Bromley, 1998; Bruce, 1993). The term *affordance* was originally introduced by Gibson (1977, 1979) to refer to the perceived and actual psychological properties of any object, as a means of explaining how individuals interact with objects in the world. A hammer, for example, easily affords hitting objects (such as nails), due to its handle (affording a grip) and its weighted end. The design of the hammer also constrains what you can do with it—a hammer does not afford turning a screw or designing a website. The use of affordance in the context of educational technology is meant more broadly to include all of the properties of the system that allow certain actions to be performed and encourage specific types of learner behavior (Norman, 1988). Using email to communicate, for example, affords asynchronous communication and easy storage (an archive) of exchanges. Email does not afford synchronous communication in the way that a phone call, a face-to-face conversation, or instant-messaging does. Nor does email afford the conveyance of subtleties of tone, intent, and mood.

In this context, it is important to distinguish between affordances and constraints of a technology that are *inherent* to the technology and those that are *imposed from outside* by the user. We often approach technologies with our own biases and predilections related to appropriate and inappropriate ways of using them. Cognitive scientists use the phrase "*functional fixedness*" to describe the manner in which the ideas we hold about an object's function can inhibit our ability to use the object for a different function (Birch, 1945; German & Barrett, 2005). Functional fixedness often stands in the way of creative uses of technologies. Overcoming this is essential for the intelligent and creative application of technology for learning. For example, a whiteboard has certain constraints and affordances: it is heavy and difficult to move, yet it is easy to write on and erase, and it can function as a public "writing space" to share ideas with others. These constraints and affordances, however, do not necessarily determine how a whiteboard can be used. The manner in which a whiteboard is used in a classroom as opposed to a science lab clearly indicates that the function of a whiteboard is determined very much by the context in which it is used. Similarly, although email is a tool for communication, it can be used to aid creative writing, and PowerPoint, a presentation tool, can be used as a medium for artistic creativity (Byrne, 2003). Thus, creative uses of technology require us to go beyond this "functional fixedness" so that we can innovatively repurpose existing tools toward pedagogical ends. Many excellent examples of such creative repurposing can be found in this book. In particular, see Chapter 13 by Bull, Bell, and Hammond which describes a range of different uses for a spreadsheet program.

## Technology and its complex role in teaching

*Technology integration* (the act of including technology in teaching) is not a new phenomenon. For example, although by today's standards we rarely consider writing to be a technology, early cultures found writing to be "an external, alien technology, as many people today think of the computer" (Ong, 1982, p. 81). Plato, for example, deliberated over the many constraints and affordances of this new technology, reasoning that this new technology may prove to be a crutch that causes the populace to lose the capability to trust their own memory.

There are several reasons why introducing technology complicates the processes of teaching. There are social and institutional contexts that are unsupportive of teachers' efforts to integrate technology. Teachers have often been provided with inadequate training for this task. The diverse contexts of teaching and learning suggest that there is not "one way" that will work for everyone. Even when we restrict our discussion to particular technologies in fixed contexts, the decision to use a technology in one's teaching introduces a myriad of affordances for teaching content and engaging learners, as well as a number of constraints on what functions technologies can serve in the classroom. Understanding the complexities of technology integration requires us to offer a richer description of what we mean by the word "technology."



Issues of technology integration apply to both analog and digital, and new and old technologies. As a matter of practical significance, however, most of the technologies under consideration in the current literature (e.g., computers, software, and the Internet) are newer and digital. Newer digital technologies have some inherent properties that make it difficult for teachers to apply them in straightforward ways. Thus, it is important for us to develop a better understanding of the affordances and constraints inherent in digital technologies, since much of the discussion today is about these technologies.

Most traditional pedagogical technologies are characterized by *specificity* (a pencil is for writing, while a microscope is for viewing small objects); *stability* (pencils, pendulums, microscopes, and chalkboards have not changed a great deal over time); and *transparency of function* (the inner-workings of the pencil or the pendulum are quite simple and directly related to their function) (Simon, 1969). Over time, these technologies achieve a *transparency of perception* (Bruce & Hogan, 1998), they have become commonplace and in most cases are not even considered technologies. Digital technologies—such as computers, and hand-held devices, and software applications—in contrast, are *protean* (usable in many different ways) (Papert, 1980), *unstable* (rapidly changing), and *opaque* (the inner-workings are hidden from users) (Turkle, 1995). We describe each of these factors complicating the inclusion of technology in the sections below.

### *Digital technologies are protean in nature*

The digital computer is unique in its ability to store, deliver, and help manipulate a variety of symbol systems: visual, acoustic, textual, and numerical. As a tool, the computer (or the computer application or system) provides humans with new ability or greater power, allowing people to do things they could not do before, or to do familiar things more easily (Papert, 1980). Computers can dynamically simulate the details of any other medium including those that cannot exist physically, making it a meta-medium with degrees of freedom for representation and expression never before encountered and as yet barely investigated (Kay, 1984).

This protean nature also means that digital technologies are many different things to different people. The digital computer can be a tool for communication (through email or instant messaging), a tool for design and construction (through software for scientific modeling or software for designing websites, themselves very different activities), a tool for inquiry (such as through digital libraries and digital probes), and a tool for artistic expression (through image, movie, and audio design software programs). This protean nature gives digital technologies their greatest strength and is the main reason why computers have applications in nearly every field of human activity. These strengths, however, come at a cost—that of significantly increasing the complexity of having to use these different symbol systems, making them difficult to learn and use. It is no surprise that the introduction of digital technologies into the classroom further complicates the kinds of problems and issues teachers face.

*Digital technologies are functionally opaque*

That is, the inner workings of most contemporary technologies are hidden from those who use them. The computer becomes a *virtual* domain in which cause and effect relationships are divorced from everyday rules. This quality makes our interactions with computers symbolic and often quite arbitrary (Turkle, 1995). This separation often makes learning to work with computers difficult—akin to learning a new language or culture. The fact that most software tools available today are designed for the world of business and work, not education, further contributes to this opacity (Zhao, 2003). Adapting general-purpose tools created for the world of business (e.g., spreadsheet programs) to the classroom context requires working through this opacity (and our functional fixedness) to reconfigure and repurpose these existing technologies for pedagogical purposes.

*Digital technologies are unstable*

The instability of digital technologies is manifest in two ways. First, the knowledge required to learn to use digital technologies is never fixed. Technology changes quickly, causing hardware and software applications to become outdated every few years. One has to continually keep up with the changing demands of new technologies, be they Hypercard, Logo, web pages, AJAX, blogs, wikis, podcasts, or the types of social bookmarking software loosely aggregated under the evolving term *Web 2.0*. Moreover, these rapid changes often happen in piecemeal fashion, which leads to users having to work with a variety of versions of software and hardware, some of which may be incompatible with one another. A second consequence of rapid technological change is that the technologies we use are often not fully tested and robust. Most software programs are error-prone and riddled with bugs. Hardware evolution also lends itself to imperfect work environments. For instance, the rapid changes in wireless protocols can leave users frustrated with connections that are too often unreliable. Though the specifics may change, these are issues, in some form or the other, that all users of digital technologies have to contend with. Thus, learning to use the technologies (and integrating into the curriculum) is not a one-shot deal. The instability of digital technologies requires that teachers become life-long learners who are willing to contend with ambiguity, frustration, and change.

These inherent characteristics of digital technology are not the only barriers to technology integration. Another series of barriers are more social, institutional, or contextual in nature. We describe a few of them below.



*Teachers often have inadequate (or inappropriate) experience*

Teachers often lack experience with using digital technologies for teaching and learning. Many teachers earned degrees at a time when educational technology was at a very different stage of development than it is today. It is, thus, not surprising that many teachers do not consider themselves sufficiently prepared to use technology in the classroom, and oftentimes do not appreciate its value or relevance to the classroom. Acquiring a new knowledge base and skill set can be quite challenging, particularly if it is a time-intensive activity that must fit into a busy schedule. However, these skills are unlikely to be used unless teachers can conceive of technology uses that are consistent with their existing pedagogical beliefs (Ertmer, 2005). Research suggests that an innovation is less likely to be adopted if it deviates too greatly from prevailing values, pedagogical beliefs, and practices of the teachers (Zhao, Pugh, Sheldon, & Byers, 2002). Learning to become flexible, creative educators who can transcend functional fixedness and other barriers is an ongoing and complicated process and must be confronted at both pre- and in-service levels. These topics are addressed by every chapter in this volume, but are the specific focus of Chapters 11 and 12 by Niess and Harris, respectively.

*Technology is often considered to be somebody else's problem*

Technology integration is made even more complex by the kinds of *social and institutional contexts* in which teachers work. Unfortunately, the problem of technology integration has often become what we have named the "somebody else's problem" (SEP) syndrome (Koehler, Mishra, Hershey, & Peruski, 2004). Technology and pedagogy are often considered domains that are ruled by different groups of people—teachers and instructors, who are in charge of pedagogy; and technologists, who are in charge of the technology. Similar to C. P. Snow's (1959) idea of two cultures of scientists and artists, teachers and techies live in different worlds and often hold curiously distorted images of each other. On one hand, technologists view non-technologists as Luddites, conservative, resistant to change, and oblivious to the transformative power of technology. On the other hand, non-technologists tend to view technologists as being shallowly enthusiastic, ignorant of education and learning theories, and unaware of the realities of classrooms and schools. These two groups read different journals, visit different conferences, and can have fundamentally different visions of the role of technology in the classroom. The chasm between these two groups is not unbridgeable, because it is clear that teachers use technology, either technologies that have become transparent to them (e.g., the chalkboard and the overhead projector) or in personal contexts outside of the classroom (e.g., the Internet, MP3 players, and DVD players). Likewise, technologists in schools know something about teaching and learning. Often they are former teachers or current teachers working full- or part-time. Yet, the phenomenon of two worlds is sociologically and psychologically real, especially as it applies to newer technologies.

It is not easy for teachers to navigate between these two worlds, worlds in which the norms, values, and language can be different. As we argue later, a complete understanding of teaching with technology involves breaking down this false dichotomy between pedagogy and technology. This tension between educators and technologists can complicate the teacher's role greatly, concomitantly discouraging effective technology integration. Chapter 13 by Bull, Bell, and Hammond offers insight into just how these institutional barriers can (and need to) be reduced.

### *Classroom contexts are varied and diverse*

Surrounding all the things that teachers should know about technologies and how to use them in their classrooms are the circumstances, or contexts, in which each teaches. As we argue more fully later, there is no such thing as a "perfect solution" to the problem of integrating technology into a curriculum. Instead, integration efforts should always be custom-designed for particular subject matter ideas in specific classroom contexts.

In several ways, the contexts of teaching reflect several *divides*, each of which further complicates the issue of technology integration in classrooms. One divide, for example, is between the *digital natives* (the first generation of students to live and grow up entirely surrounded by digital technology) and the *digital immigrants* (the teachers who have "migrated" to this technology later in life) (Prensky, 2001). The natives represent a challenge to immigrant teachers, because of differences in comfort levels and knowledge of technology, and a concomitant clash of culture, language, and values. Another divide is the well-known *digital divide* between those who have access to the latest technology, and those who do not (see Digital Divide.org, 2006). This divide takes many forms, and has complex implications for how teachers approach these contexts, as is addressed in Chapter 10 by Kelly.

## Teaching with technology as a wicked problem

Technology integration has often been considered a kind of problem-solving, the goal of which is to find the appropriate technological solutions to pedagogical problems. However, matters are not this clear-cut. Integrating technology in the classroom is a complex and ill-structured problem involving the convoluted interaction of multiple factors, with few hard and fast rules that apply across contexts and cases.

One fruitful way of thinking about the complex problem of teaching with technology is to view it as a "wicked problem" (Rittel & Webber, 1973). Rittel and Webber argued that wicked problems, in contrast to "tame" problems (such as those in mathematics, chess, etc.), have incomplete, contradictory, and changing requirements. Solutions to wicked problems are often difficult



to realize (and maybe even recognize) because of complex interdependencies among a large number of contextually bound variables. Wicked problems, they argue, cannot be solved in a traditional linear fashion, because the problem definition itself evolves as new solutions are considered and/or implemented. Rittel and Webber stated that while attempting to solve a wicked problem, the solution of one of its aspects may reveal or create another, even more complex problem. Moreover, wicked problems have no stopping rule—and solutions to wicked problems are not right or wrong, simply "better," "worse," "good enough," or "not good enough." Most importantly, every wicked problem is essentially unique and novel. There are so many factors and conditions—all dynamic—that no two wicked problems are alike. Accordingly, solutions to wicked problems will always be custom-designed. For this reason, there is no definitive solution to a technology integration problem. Each issue raised by technology integration presents an ever evolving set of interlocking issues and constraints.

Rittel and Webber show that the biggest mistake that one can make when tackling a wicked problem is to think of it as a "normal" or "tame problem" that can be tackled in conventional ways. Wicked problems always occur in social contexts—in the case of technology integration, that of classrooms. The diversity of teachers, students, and technology coordinators who operate in this social context bring different goals, objectives, and beliefs to the table, and thereby contribute to the wickedness of this problem. Indeed it is the social, psychological complexity of these problems—rarely their technical complexity—that overwhelms standard problem-solving approaches. These solutions become a source for learning, leading to newer knowledge, and unintended consequences, that can lead to more wicked problems, which in turn can lead to newer knowledge and so on in a continuous spiral or development. This process of problem-seeking, problem-solving, and knowledge generation does not typically end when all possible problems are solved but rather when external factors (such as running out of time, money, information, support, or other resources) come into play. As Simon argues, in contexts such as these, the best we can hope for is *satisficing*, i.e. achieving a satisfactory solution, an outcome that, given the circumstances, is good enough.

Describing teaching as a wicked problem, full of complexity and ill-structuredness, does not suggest that this problem lacks structure. Ill-structuredness demands that understanding a typical case in the domain in question requires understanding a variety of complex concepts (and their contextually defined interactions), and that these concepts interact in patterns that are not consistent across cases. Complexity often emerges from a smaller set of tractable and understandable phenomena that interact with one another.

The wicked problems of technology integration require us to develop new ways of confronting this complexity. We argue that at the heart of good teaching with technology are three core components: *content, pedagogy, and* *technology* and the relationships between them. It is these interactions, between and among these components, playing out differently across diverse contexts, that account for the wide variations seen in educational technology integration. These three knowledge bases (content, pedagogy, and technology) form the core of the TPCK framework. We offer an overview of the framework below, though more detailed descriptions may be found in other published reports (Koehler, Mishra, Hershey, & Peruski, 2004; Koehler & Mishra, 2005a, 2005b; Mishra & Koehler, 2006). It is important to note that this perspective is consistent with other researchers and approaches that have attempted to extend Shulman's idea of pedagogical content knowledge (PCK) to the domain of educational technology.[3]

## The TPCK model

The TPCK framework builds on Shulman's (1987, 1986) descriptions of pedagogical content knowledge to describe how teachers' understanding of technologies and pedagogical content knowledge interact with one another to produce effective teaching with technology. (See note #3 for an overview of the evolution of these ideas.) In this model (see Figure 1.1), there are three main components of knowledge: content, pedagogy, and technology. Equally important to the model are the interactions among these bodies of knowledge, represented as pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPCK).

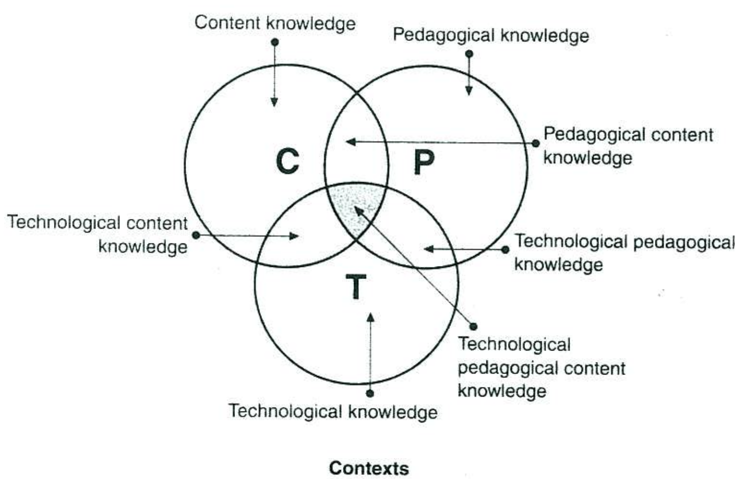


**Figure 1.1** The TPCK framework and its knowledge components.



The goal of describing each of these bodies of knowledge is not to engage in philosophical discussions about the nature of knowledge. Although many philosophers have typically defined knowledge as "justified true belief" and have spent decades, if not centuries, attempting to understand each of these words, the definition of knowledge used here is more pragmatic and is influenced by scholars such as Dewey, Schon, and Perkins (Dewey, 1934; Dewey & Bentley; 1949; Perkins, 1986; Schon, 1983, 1987, 1996). Perkins in particular poses a provocative metaphor: that of "knowledge as design" (Perkins, 1986). In fact he goes on to argue that knowledge can be considered a tool that is designed and adapted to a purpose. As he says:

> To think of knowledge as design is to think of it as an implement one constructs and wields rather than a given one discovers and beholds. The kinesthetic imagery implicit in knowledge as design fosters an active view of understanding worthy of emphasis in teaching and learning.
>
> (p. 132)

In this view of knowledge, the truth-value of the knowledge is less important than what you can do with that knowledge—what has also been called usable knowledge (Kelly, 2003; Lagemann, 2002; National Research Council [NRC], 2002). We briefly describe each component of the TPCK model below.

### *Content knowledge (CK)*

Content knowledge is knowledge about the actual subject matter that is to be learned or taught. The content to be covered in middle school science or history is different from the content to be covered in an undergraduate course on art appreciation or a graduate seminar on astrophysics. Knowledge of content is of critical importance for teachers. As Shulman (1986) noted, this would include: knowledge of concepts, theories, ideas, organizational frameworks, knowledge of evidence and proof, as well as established practices and approaches towards developing such knowledge. Knowledge and the nature of inquiry differ greatly between fields and it is important that teachers understand the deeper knowledge fundamentals of the disciplines in which they teach. In the case of science, for example, this would include knowledge of scientific facts and theories, the scientific method, and evidence-based reasoning. In the case of art appreciation, such knowledge would include knowledge of art history, famous paintings, sculptures, artists and their historical contexts, as well as knowledge of aesthetic and psychological theories for evaluating art. The cost of not having a comprehensive base of content knowledge can be quite prohibitive; students can receive incorrect information and develop misconceptions about the content area (National Research Council, 2000; Pfundt & Duit, 2000). Yet content knowledge, in and of itself, is an ill-structured domain, and as the culture wars (Zimmerman, 2002) and the

Great Books controversies (Bloom, 1987; Casement, 1997; Levine, 1996) as well as court battles over the teaching of evolution (Pennock, 2001) demonstrate, issues of content can be areas of significant contention and disagreement. The bulk of the chapters in this book describe how differences among content knowledge domains are reflected in differing strategies to integrate educational technologies in teacher education and classroom practice.

*Pedagogical knowledge (PK)*

Pedagogical knowledge is deep knowledge about the processes and practices or methods of teaching and learning and encompasses (among other things) overall educational purposes, values, and aims. This is a generic form of knowledge that applies to student learning, classroom management, lesson plan development and implementation, and student evaluation. It includes knowledge about techniques or methods used in the classroom, the nature of the target audience, and strategies for evaluating student understanding. A teacher with deep pedagogical knowledge understands how students construct knowledge and acquire skills, and how they develop habits of mind and positive dispositions towards learning. As such, pedagogical knowledge requires an understanding of cognitive, social, and developmental theories of learning and how they apply to students in the classroom.

*Pedagogical content knowledge (PCK)*

Pedagogical content knowledge is consistent with, and similar to Shulman's idea of knowledge of pedagogy that is applicable to the teaching of specific content. PCK covers the core business of teaching, learning, curriculum, assessment, and reporting, such as the conditions that promote learning and the links among curriculum, assessment, and pedagogy. An awareness of common misconceptions and ways of looking at them, the importance of forging links and connections between different content ideas, students' prior knowledge, alternative teaching strategies, and the flexibility that comes from exploring alternative ways of looking at the same idea or problem are all essential for effective teaching.

Central to Shulman's conceptualization of PCK is the notion of the transformation of the subject matter for teaching. Specifically, according to Shulman (1986), this transformation occurs as the teacher interprets the subject matter, finds multiple ways to represent it, and adapts and tailors the instructional materials to alternative conceptions and students' prior knowledge. An excellent example of such a transformation can be seen in John Lee's Chapter 6 on the application of TPCK to social studies. As Lee argues, social studies does not exist as a distinct discipline but rather is configured from multiple sources including history, geography, political science, economics, behavioral sciences, cultural studies, and more. According to Lee, the domain of social studies emerges as a consequence of the pedagogical decision



to educate students about civic preparation. In other words, without this pedagogical decision, the domain of social studies would not exist.

*Technology knowledge (TK)*

Technology knowledge is always in a state of flux—more so than the other two "core" knowledge domains in the TPCK framework (pedagogy and content). This makes pinning it down notoriously difficult. Earlier in this chapter, we described the manner in which technology continually changes and how keeping up-to-date with it can become a full-time job, in and of itself. This also means that any definition of technology knowledge is in danger of becoming outdated by the time this text has been written, edited, proofread, and published.[4] That said, we believe that there are certain ways of thinking about and working with technology that can apply to all technology tools.

In that sense, our definition of TK is close to that of fluency of information technology (FITness) as proposed by the Committee of Information Technology Literacy of the National Research Council (NRC, 1999). They argue that FITness goes beyond traditional notions of computer literacy to require that persons understand information technology broadly enough to apply it productively at work and in their everyday lives, to recognize when information technology can assist or impede the achievement of a goal, and to continually adapt to changes in information technology. FITness therefore requires a deeper, more essential understanding and mastery of information technology for information processing, communication, and problem-solving than does the traditional definition of computer literacy. Acquiring TK in this manner enables a person to accomplish a variety of different tasks using information technology and to develop different ways of accomplishing a given task. This conceptualization of TK does not posit an "end state" but rather sees it developmentally, as evolving over a lifetime of generative, open-ended interaction with technology.

*Technological content knowledge (TCK)*

Technology and knowledge have a deep historical relationship. Progress in fields as diverse as medicine and history, or archeology and physics have coincided with the development of new technologies that afford the representation and manipulation of data in new and fruitful ways. Consider Roentgen's discovery of X-rays or the technique of Carbon-14 dating and the influence of these technologies in the fields of medicine and archeology. Consider also how the advent of the digital computer changed the nature of physics and mathematics, and placed a greater emphasis on the role of simulation in understanding phenomena.[5] Technological changes have also offered new metaphors for understanding the world. Viewing the heart as a pump, or the brain as an information-processing machine, are just some of the ways in which technologies have provided new perspectives for understanding phenomena in the world. These representational and metaphorical connections are not superficial. They often have led to fundamental changes in the nature of the discipline itself.

Understanding the impact of technology on the practices and knowledge of a given discipline is critical if we are to develop appropriate technological tools for educational purposes. The choice of technologies affords and constrains the types of content ideas that can be taught. Likewise, certain content decisions can limit the types of technologies that can be used. Technology constrains the types of possible representations but conversely affords the construction of newer and more varied representations. Furthermore, technological tools can provide a greater degree of flexibility in navigating across these representations.

This book contains many examples of the manner in which representations are changed with the introduction of technology. For instance, consider Grandgenett's Chapter 7 examples of fractals, which require the computational power of the computer to be created and to be taught. Fractals, as we conceive of them now, would not be possible without the computational and visual representational power of the digital computer. McCrory's Chapter 9 on science and DePlatchett's Chapter 8 on art provide excellent examples of how new technologies are changing the very nature of physics and art, respectively.

Thus, we can define TCK as an understanding of the manner in which technology and content influence and constrain one another. Teachers need to master more than the subject matter they teach, they must also have a deep understanding of the manner in which the subject matter (or the kinds of representations that can be constructed) can be changed by the application of technology. Teachers need to understand which specific technologies are best suited for addressing subject-matter learning in their domains and how the content dictates or perhaps even changes the technology—or vice versa.

In some ways, TCK is the most neglected aspect of the various intersections in the TPCK framework. As Thompson (2006) says, this framework "suggests that teachers' experiences with technology need to be specific to different content areas" (p. 46). This monograph attempts to redress this neglect by asking scholars in different disciplinary contexts to describe how technology and content are reciprocally related in their particular domains.

### *Technological pedagogical knowledge (TPK)*

Technological pedagogical knowledge is an understanding of how teaching and learning changes when particular technologies are used. This includes knowing the pedagogical affordances and constraints of a range of technological tools as they relate to disciplinarily and developmentally appropriate pedagogical designs and strategies. This requires getting a deeper understanding of the constraints and affordances of technologies and the disciplinary contexts within which they function.



Consider the whiteboard example provided earlier. As we described, the nature of this technology—which has been in use for a long time—in some ways pre-supposes the kinds of functions it can serve. It is usually placed in the front of the classroom and under the control of the teacher. This, in turn, imposes a particular physical order in the classroom. For example, the use of a whiteboard can determine the placement of tables and chairs and frames the nature of student–teacher interaction. For instance, the teacher has primary ownership of the whiteboard, and students can use it only when called upon by the teacher. However, it would be incorrect to say that there is only one way in which whiteboards can be used. One has only to compare the use of a whiteboard in a brainstorming meeting in a business setting to see a rather different use of this technology. In such a setting, the whiteboard is not under the purview of a single individual, but rather it can be used by anybody in the group, and it becomes the focal point around which discussion and the negotiation/construction of meaning occurs. Thus an important part of TPK is developing creative flexibility with available tools in order to repurpose them for specific pedagogical purposes.

TPK becomes particularly important because most popular software programs are not designed for educational purposes. Software programs such as the Microsoft Office Suite (Word, PowerPoint, Excel, Entourage, and MSN Messenger) are usually designed for a businesses environment. Furthermore, web-based technologies such as blogs or podcasts are designed for purposes of entertainment/communication/social networking. Teachers need to reject functional fixedness, and develop skills to look beyond the immediate technology and "reconfigure it" for their own pedagogical purposes. Thus TPK requires a forward-looking, creative, and open-minded seeking of technology, not for its own sake, but for the sake of advancing student learning and understanding. Harris in Chapter 12 on in-service teacher education, introduces the idea of activity types as one way of assisting novice teachers to develop such an open-minded perspective on repurposing of technology.

### *Technological pedagogical content knowledge (TPCK)*

TPCK is an emergent form of knowledge that goes beyond all three components (content, pedagogy, and technology). Technological pedagogical content knowledge is an understanding that emerges from an *interaction* of content, pedagogy, and technology knowledge. Underlying truly meaningful and deeply skilled teaching with technology, TPCK is different from knowledge of all three concepts individually. We argue that TPCK is the basis of effective teaching with technology and requires an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones.

By simultaneously integrating knowledge of technology, pedagogy, and content, TPCK is a form of knowledge that expert teachers bring into play any time they teach. Each "wicked problem" or situation presented to teachers is a unique combination or weaving together of these three factors, and accordingly, there is no single technological solution that applies for every teacher, every course, or every view of teaching. Rather, solutions lie in the ability of a teacher to flexibly navigate the space defined by the three elements of content, pedagogy, and technology and the complex interactions among these elements in specific contexts. Ignoring the complexity inherent in each knowledge component, or the complexity of the relationships among these components, can lead to oversimplified solutions or failure. Thus, teachers need to develop fluency and cognitive flexibility not just in each of these key domains (T, P, and C) but also in the manner in which these domains interrelate, so that they can effect solutions that are sensitive to specific contexts. This is the kind of deep, flexible, pragmatic, and nuanced understanding of teaching with technology that we advocate in this monograph and is further examined by the other chapters in this volume.

The act of seeing technology, pedagogy, and content as three knowledge bases is not straightforward. As we have said before:

> separating the three components (content, pedagogy, and technology) ... is an analytic act and one that is difficult to tease out in practice. In actuality, these components exist in a state of dynamic equilibrium or, as the philosopher Kuhn (1977) said in a different context, in a state of "essential tension" ... Viewing any of these components in isolation from the others represents a real disservice to good teaching. Teaching and learning with technology exist in a dynamic transactional relationship (Bruce, 1997; Dewey & Bentley, 1949; Rosenblatt, 1978) between the three components in our framework; a change in any one of the factors has to be "compensated" by changes in the other two.
>
> (Mishra & Koehler, 2006, p. 1029)

This compensation is most evident whenever a new educational technology suddenly forces teachers to confront basic educational issues and *reconstruct the dynamic equilibrium among all three elements.* This view inverts the conventional perspective that content simply needs to be converted to fit a new technology—that is, the pedagogical goals and technologies are derived from the content area. Things are rarely that simple, particularly when newer



technologies are employed. The introduction of the Internet—particularly the rise of online learning—is an example of the arrival of a technology that forced educators to think about core pedagogical issues such as how to represent content on the web, and how to connect students with the subject matter and with one another (Peruski & Mishra, 2004).

In this context, consider the example of cognitive flexibility hypertexts (CFTs) as espoused by Spiro and his colleagues (Spiro, Feltovich, Jacobson, & Coulson, 1991; Spiro & Jehng, 1990). Over the years, many CFT hypertexts have been developed by academics, often for use in research. By their nature, these hypertext environments are constrained to specialty software projects with focused subject matter, with limited availability to other users outside of universities. Thus, most of the work in this area has been restricted to publications, research papers, and journal articles. The advent of community-developed hypertexts and encyclopedias, user-generated metadata (also known as social bookmarking), and their use at popular web sites such as Wikipedia, Furl, Delicious, YouTube, and Flickr has suddenly moved core CFT ideas from the research lab into the real world. Educators are now realizing the constructivist power of folksonomies,[6] and other user-created tagging/categorization schemes, to reconfigure how we understand texts and the relationships among them. In this context, it is the advent of a new technology that "drives" the kinds of decisions we make about content and pedagogy, by highlighting or revealing previously hidden facets of the content, by enabling connections between diverse domains of knowledge, or supporting newer forms of pedagogy. The decision to use hypertext, for example, by necessity restricts the type of pedagogical representations available, and the content that may be represented, thus forcing teachers to select curriculum content that is most appropriate given the affordances of this particular technology.

This influence of technology on pedagogy and content (as the previous examples showed) is not unidirectional. A good example of how the pedagogical constraints of schools can restrict how technology is designed and used relates to the use of educational computer games. A study comparing commercial games with educational games found that commercial games often were more demanding than educational games in terms of cognitive effort as well as in time required for mastery (Heeter *et al.*, 2003). Educational games were easier to install, easier to learn, less complex, shorter, less challenging to play, and required less social interaction than commercial games. Heeter and colleagues asserted that these qualities resulted mainly from the need to fit game-playing into standard school schedule 45–50 minute timeslots. What was clear from the study was that the constraints of working within a school setting led to design solutions that limited playability, particularly related to the length and complexity of game play, and thus limited what students could learn from the game. The authors argue that constraining games to a format that is playable in classroom settings may pose a bigger challenge to designers interested in creating fun, educational games than the need to integrate curriculum-based subject matter. This emphasis on pedagogy through play leads Heeter and colleagues to argue that educational games are schizophrenic, in that they continually try to serve two masters, content learning and fun.

The above examples are intended to illustrate the complex ways in which content, pedagogy, and technology interact with varying levels of success. Teaching with technology is a difficult thing to do well. The TPCK framework suggests that content, pedagogy, and technology have roles to play individually and together. Teaching successfully with technology requires continually creating, maintaining, and re-establishing a dynamic equilibrium between each component. It is worth noting that a range of factors influence how this equilibrium is reached, including subject-matter specific ones (hence the content component of the model), and therefore we recommend the other chapters in this volume for guidance on how subject-matter areas impact teachers' TPCK. However, we do suggest that there are some general implications for teachers who try to achieve this equilibrium, and we explore what this view implies for teaching practice. That is the focus of the next section.

## Teacher knowledge in practice, or teachers as curriculum designers

Our description of the unique and case-specific nature of wicked problem solving, and the kinds of knowledge required to function in such contexts, strongly supports the idea that there is no general solution to a teaching problem for every context, every subject matter, every technology, or every classroom. In making his argument for knowledge as design, Perkins suggests that practitioners have to "learn to see through design-colored glasses" and, "be inventive" (p. 36) in how we approach the problems in our fields. Joseph Schwab (1983) offered an apt description of the complexity of the teacher's role and the kinds of flexibility teachers need to possess in order to succeed in classroom environments. This description is also an important reminder that the teacher is the primary, if not exclusive, conduit for any changes that can occur in the classroom. As Schwab says:

> Teachers will not and cannot be merely told what to do ... Teachers are not assembly line operators, and will not so behave ... There are thousands of ingenious ways in which commands on what and how to teach can, will, and must be modified or circumvented in the actual moments of teaching. Teachers practice an art. Moments of choice of what to do, how to do it, with whom and at what pace, arise hundreds of times a school day, and arise differently every day and with every group of students. No command or instruction can be so formulated as to control that kind of artistic judgment and behavior, with its demand for frequent, instant choices of ways to meet an ever-varying situation.
>
> (p. 245)



What this quote makes clear is that curricula do not exist independently of teachers. Teachers are "an integral part of the curriculum constructed and enacted in classrooms" (Clandinin & Connelly, 1992 p. 363). The teacher, Dewey argued, is not merely the creator of the curriculum, but is a part of it: teachers are *curriculum designers*.[7] The idea of teachers as curriculum designers is based on an awareness of the fact that implementation decisions lie primarily in the hands of particular teachers in particular classrooms. Teachers are active participants in any implementation or instructional reform we seek to achieve, and thus require a certain degree of autonomy and power in making pedagogical decisions. Teachers construct curricula through an organic process of iterative design and refinement, negotiating among existing constraints, to create contingent conditions for learning. This process, of enacting teaching (with or without technology) in ways that are uniquely shaped by their personalities, histories, ideas, beliefs, and knowledge, has been called *bricolage*.[8] Curriculum design as bricolage emphasizes situational creativity and flexibility, through tactically and contingently selecting and unselecting elements from what is available. Teachers constantly negotiate a balance between technology, pedagogy, and content in ways that are appropriate to the specific parameters of an ever-changing educational context.

This view of teaching has significant implications for teacher education and teacher professional development. We list some of them below.

### *Approaches that merely teach skills (technology or otherwise) do not go far enough*

Learning about technology (how to use email, word processing, or the latest version of a computer operating system) is different than learning what to do with it. Clearly, a solid understanding of knowledge in each individual domain would be the basis for developing TPCK. Developing these knowledge bases is necessary but clearly not sufficient. For instance, teaching technology skills alone (the T in our model) does little to help teachers develop knowledge about how to use digital tools to teach more effectively (TP), navigate the relationships between technology and content representations (CT), or how to use technology to help students learn a particular topic (TPC). Likewise, isolating learning about curriculum content (C), or general pedagogical skills (P), will not necessarily help teachers develop an understanding of how to put this knowledge to good use.

### *The spiral-like development of TPCK*

In this chapter we have argued that digital technologies, in particular, require a greater level of thought and work on the part of the teacher seeking to integrate them in their teaching. The TPCK framework, however, should not be seen as being specific to just the application of newer digital technologies. Teacher educators need to be sensitive to the fact that *all* technologies come with pedagogical affordances and constraints, and in that sense the TPCK framework can be applied to any technology, as the range of examples used in this chapter, from whiteboard to wikis, testifies. Thus, teacher-training programs may seek to develop TPCK in a gradual and spiral-like manner, beginning possibly with more standard and familiar technologies (areas in which teachers may already have developed TPCK), and moving on to more advanced or non-familiar technological solutions.

*The need for a greater emphasis on the demands of subject matter*

This is the main theme of this book, and one that is highlighted in every chapter of this volume. Instead of applying technological tools to every content area uniformly, teachers should come to understand that the various affordances and constraints of technology differ by curricular subject-matter content or pedagogical approach. For example, a teacher interested in integrating technology into history education may consider the use of primary sources available on the Internet, while another may choose to have students develop hypertexts that focus on the inter-linked cause–effect relationships between historical events. A mathematics teacher may focus on the representational capabilities of technology (graphs, symbols, etc.), or on different methods of proof.

*Practice (in curriculum design and teaching) is an important route to learning*

It is not always the case that conceptual learning precedes the ability to apply that knowledge to practice. Learning in complex and ill-structured domains often happens best through working through problems or cases (Shulman, 1986; Williams, 1992)—that is, working with the wicked problems posed by integrating technology into effective practice. When designers tackle these problems, their solutions are generative, in that each solution leads to newer knowledge, and unintended consequences, which are likely to lead to further wicked problems. The learning of new concepts and their inter-relationships comes from practice; not the rote application of general principles. Teacher educators must find ways to provide preservice teachers multiple opportunities to work through these problems of practice before they enter their first classrooms, whether by internships, case-studies (traditional or video), or problem-based learning scenarios. This is much easier said than done, and the issues/concerns in this domain are discussed in Chapter 11 by Niess.

*Context is important to learning and situating teacher knowledge*

Because teaching is a complex and ill-structured problem, there are few—perhaps no—general principles that apply in every situation. In short, context matters. Solutions to "wicked problems" require nuanced understanding that goes beyond the general principles of content, technology, and pedagogy. A deep understanding of the interactions among these bodies of knowledge, and



how they are bound in particular contexts (including knowledge of particular students, school social networks, parental concerns, etc.), imparts the kind of flexibility teachers need in order to succeed. In viewing teachers as curriculum designers, we acknowledge that they actively adapt to multiple contexts and changing conditions, rather than trying to apply general approaches. Chapters 11 and 12 by Niess and Harris, respectively, investigate the implications of viewing the TPCK framework through the lens of teachers as curriculum designers.

## Conclusion

In his book *Life in the Classroom* (1968), Philip Jackson reported the results of one of the first studies that attempted to describe and understand the mental constructs and processes that underlie teacher behavior. In representing the full complexity of the teacher's task, Jackson made conceptual distinctions that fit the teacher's frame of reference—for instance, the preactive and the interactive stages of teaching—and drew attention to the importance of describing the thought processes and planning strategies of teachers (the so-called "hidden side of teaching") in an attempt to develop a more complete understanding of classroom processes. Jackson's pioneering work led to a flurry of research studies that focused attention on teachers' thinking and decision-making processes (Clark & Peterson, 1986), a line of research that hopes to "understand and explain how and why the observable activities of teachers' professional lives take on the forms and functions they do" (p. 255). A major goal of this research was to understand the relationships between two key domains: teacher thought processes; and teachers' actions and their observable effects. In this manner we see the current work—this chapter as well as the others in this book—as extending this tradition of research and scholarship. We need to develop better techniques for discovering and describing how knowledge is implemented and instantiated in practice, and, just as importantly, how the act of doing influences the nature of knowledge itself. The "knowledge as design" notion has at its heart this interactive, bi-directional relationship between thought and action, embedded within ill-structured, complex contexts.

Reitman (1965) described ill-defined or ill-structured problems as those "whose definition included one or more parameters, the values of which are left unspecified" (p. 112). The classic example he gave was the problem of composing a fugue, which in its simplest form has just one requirement: that of having the quality of "fugueness." Of course, this requirement also contains within itself a range of cultural, technical, historical, and psychological values and constraints—its "context," as it were. We particularly like this example as an analogy to instruction, because teaching is similar to creating original music of multiple genres, not only fugues, and represents one of the highest forms of human achievement, which requires the creative dovetailing and melding of both technical and aesthetic skills. The TPCK framework offers insight, we hope, into how the myriad complexities and tensions of teaching and learning can be brought together to mutually develop teachers' and students' knowledge.

## Notes

1. Contributions of the two authors to this article were equal. We rotate the order of authorship in our writing. We would like to thank the members of the AACTE Innovation and Technology Committee for initiating this project and for providing feedback on a previous version of this chapter. Thanks are also due to Jim Ratcliffe, Leigh Graves Wolf, and Sue Barratt.
2. There are two reasons to include both older and newer technologies in our definition. First, the distinction between older and newer technologies is fuzzy. Given the rapid rate of technology change, it is difficult to pinpoint exactly at what point a particular technology goes from being "new" to "old." Second, a wide variety of technologies exist side-by-side in today's world, the MP3 Player and the radio, whiteboards and web-based learning management systems (LMS). Any framework that considers technology integration in teaching needs to accept and consider how these different technologies work together in today's classroom. This of course is not to say that all technologies are the same (clearly there are significant differences between analog and digital technologies, as described elsewhere in this chapter) but rather that our framework can (and does) accommodate a range of technologies.
3. The idea of TPCK (though not the term) has been around for a while. A precursor to the TPCK idea was a brief mention of the triad of content, theory (as opposed to pedagogy), and technology in Mishra (1998), though within the context of educational software design. A more specific focus was Pierson (1999, 2001) whose work almost exactly pre-empted the current diagrammatic conceptualization of TPCK. Keating and Evans (2001) and Zhao (2003) describe TPCK as well, while other authors have discussed similar ideas, though often under different labeling schemes. These include *integration literacy* (Gunter & Baumbach, 2004); *information and communication (ICT)-related PCK* (e.g., Angeli & Valanides, 2005); *technological content knowledge* (Slough & Connell, 2006); and *electronic PCK or e-PCK* (e.g., Franklin, 2004; Irving, 2006). Others who have demonstrated a sensitivity to the relationships between content, pedagogy, and technology include Hughes (2004), McCrory (2004), Margerum-Leys and Marx (2002), Niess (2005), and Slough and Connell (2006). Our conception of TPCK has developed over time through a series of publications and presentations (e.g., Koehler, Mishra, Hershey, & Peruski, 2004; Koehler & Mishra, 2005a, 2005b; Koehler, Mishra, & Yahya, 2007; Mishra & Koehler, 2003, 2006; Mishra, Koehler, Hershey, & Peruski, 2002), the most definitive one of which is Mishra and Koehler (2006). An updated reference list is maintained at http://www.tpck.org.
4. At the risk of sounding outdated in a few years (months?) we argue that, at this time, knowledge of technology would include a basic understanding of the full range of digital technologies (video, Internet, computers, peripheral devices, etc.) and commonplace educational technologies such as print media and overhead projectors. It also includes the ability to use important and relevant software tools (including word processing, email, and spreadsheets). Increasingly, knowledge of technology has come to include newer technologies made popular through the advancement of the Internet and gaming technologies. For instance knowledge of blogs and wikis, podcasting and tagging/social bookmarking, video games and simulations are increasingly becoming a part of the technologies that teachers need to be familiar with.
5. Though physics and mathematics approach simulation from somewhat opposite directions, physics from the side of grounded experimentation and mathematics from a more abstract axiomatic method, it is interesting to note that they both "meet" in the realm of the virtual.



6. Community-developed hypertexts, such as Wikipedia, have quickly developed a huge, hyper-linked corpus of information by simultaneously circumventing the bottlenecks of the traditional approach (the restricted subject-matter focus and a limited set of experts who could author the text). Folksonomies also expand the development of hypertexts through collaborative, open-ended categorization schemes for web pages, online photographs, and web links. Folksonomies can be best understood by comparing them with taxonomies (such as the Dewey Decimal System or Linneaean system for categorizing living creatures). Taxonomies are often developed by a select few "experts," and have "controlled vocabularies" that other users have to conform to. A folksonomy, on the other hand, is an unsystematic, emergent, bottom-up categorization scheme in which the main users are the authors of the labeling system. As must be obvious, folkonomies are often chaotic and idiosyncratic. Folksonomies are inherently open-ended and can therefore respond quickly to changes and innovations in the way users categorize Internet content (Wikipedia)
7. The word "curriculum" has a complex and tangled definitional history. Traditionally, teachers have come to be seen as separate from curriculum, and various programs (such as programmed instruction, teaching machines, computer-assisted learning, etc.) have, over the years, attempted to limit the teacher's role in curriculum development. However, it has become clear that teacher-proof curricula do not do justice to the teacher agency or the realities of classrooms. Our definition of curriculum is consistent with Clandinin and Connelly's (1992) view that the teacher is an integral part of the curriculum constructed and enacted in classrooms.
8. The word bricolage comes from the French *bricoleur*, which is normally translated as "handyman" or "tinkerer." The pedagogic sense of the word was introduced by Papert (1980) and then again in Turkle and Papert (1992), based on an earlier use by Levi-Strauss (1962). The idea here is that there are two fundamentally different ways of approaching a problem. The "engineering" way involves making careful plans and writing everything down in full detail ahead of time, while the way of the *bricoleur* is that of doing the best with what is at hand, under existing constraints and within extant contexts. This idea is also close to that of Simon's (1957) idea of satisficing as being the goal of design.

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