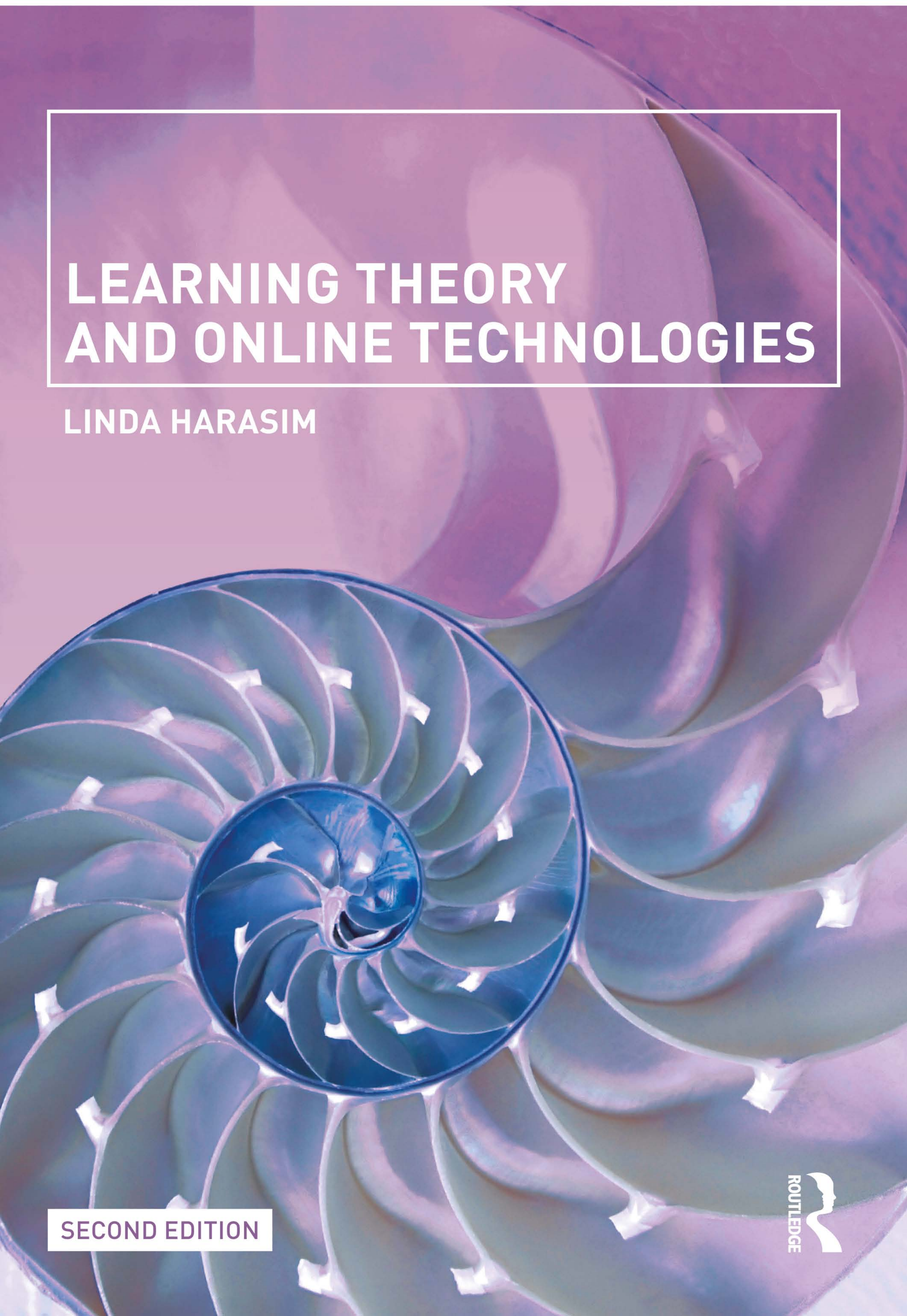

LEARNING THEORY AND ONLINE TECHNOLOGIES

LINDA HARASIM

SECOND EDITION

ROUTLEDGE

Learning Theory and Online Technologies

Learning Theory and Online Technologies offers a powerful overview of the current state of online learning, the foundations of its historical roots and growth, and a framework for distinguishing between the major approaches to online learning. It addresses pedagogy (how to design an effective online environment for learning), evaluation (how to know that students are learning), and history (how past research can guide successful online teaching and learning outcomes).

An ideal textbook for undergraduate Education and Communication programs as well as Educational Technology Masters, Ph.D., and Certificate programs, *Learning Theory and Online Technologies* provides a synthesis of the key advances in online education learning theory and the key frameworks of research, and clearly links theory and research to successful learning practice. This revised second edition updates data on digital media adoption globally, adds a new chapter on connectivism as a learning theory, and updates the chapter on online collaborative learning, renaming the theory as collaborativism and considering the challenges that arise with the growth of artificial intelligence.

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1
Introduction to Learning Theory and Technology

It is the theory that decides what we can observe.

—Albert Einstein

Chapter 1 covers the following topics:

- Introduction to learning theory in the Knowledge Age
- What is learning theory?
    - Theory and epistemology: the nature of knowledge
    - Theory and scientific method
    - Knowledge communities
- Learning theories in the 20th century
    - Behaviorist learning theory
    - Cognitivist learning theory
    - Constructivist learning theory
- Learning theories in the 21st century
    - Connectivism
    - Collaborativism aka online collaborative learning theory.

Introduction to Learning Theory in the Knowledge Age

Our personal, professional, social and cultural lives have been affected and transformed by the computer networking revolution: email, cellphones, text messaging, Twitter, participating in social networks, blogging and accessing powerful search engines using computers and/or mobile devices are common aspects of everyday life. Moreover, as aspiring or current members of the education profession (teachers, instructors, professors, trainers), the world in which we work and teach has been particularly impacted by networking technologies. The 21st century has been referred to as the Knowledge Age, a time in which knowledge has key social and economic value. Today's youth have largely been raised in the culture of the internet and view it as integral to both socializing and work. There are also strong indications that the role of technology in the 21st century is creating a Compliant Society, in which technology increasingly plays the role of teacher and is replacing the human teacher, instructor and professor. Yet educational theory and practice do not significantly reflect or address this new reality.

In our technology-driven world, it is critical and timely to study the intersection of learning theory and technology. Opportunities for educators to reflect on the implications of how we might shape and apply new communication technologies within our practice have been limited. The field is characterized by training teachers in the use of specific online tools, but a theory-informed approach to transforming our educational practice remains elusive.

In our personal lives, we have embraced new technologies for social communication. New technologies are reshaping the way we function within our communities and how we form them. We use email, Twitter, texting; participate in online forums and social networks (such as Facebook, WeChat); search massive databases; access wikis, blogs and user-generated content sites (YouTube, Instagram); or shop online with Amazon. But in our professional lives, despite our interest or need, there has been little opportunity to consider and explore new learning paradigms.

Rather than transform pedagogy by using opportunities afforded by new technologies and the changing socio-economic context of the 21st century, a common tendency among educators has been to merely add technology onto traditional ways of teaching. Examples of traditional didactic approaches to the internet are common and include the use of email, Skype and blogs for:

- transmission of course information and content to students;
- communication between student and teacher/tutor;
- transmission of lectures (PowerPoint slides, videoconferences, podcasts);
- administering quizzes and posting grades.

Such use of the internet for traditional teaching methods represents the most common educational applications of the internet and, for many educators, the only way of using it. Adopting the new technologies to serve traditional practices may not be a bad thing in itself, but educators who restrict their use of the internet to making traditional didactic teaching easier or more efficient are missing opportunities to introduce better, different or more advanced ways of learning.

While the internet and mobile technologies reshape the potential of both our professional and personal modes of communication, the challenge to transform how we think about learning and how we practice our profession confronts us. The transformative potential of the internet for learning has thus far been largely limited to quantitative change; for example, improvement in educational efficiency both in speed of delivery and in scale to deliver to massive numbers of participants. But qualitative change in how we perceive and practice teaching and learning remains in the early stages of development, largely because it is not yet well understood by educators and researchers and the field lacks a theoretical framework to guide educational design, pedagogies and use of online technologies. There are few theory-based or research-based guidelines to assist educators to develop more effective pedagogies for online learning environments. Hence educators have adopted new technologies largely through trial-and-error methods and by adapting traditional didactic practices to online environments, both within formal (primary, secondary or tertiary) and non-formal (training, certification, professional development) educational settings.

Educators are challenged to respond to the internet. There is a need to reflect on our theory of learning (even if it is implicit), and to rethink and reassess our teaching practices and pedagogical approaches in relation to the opportunities afforded by online technologies. Most professions are faced with this challenge; new technologies are transforming the world of work and the nature of the organizations in which we work. Educators are not alone in confronting the paradigmatic shift. But perhaps as educators we have the greatest responsibility and most powerful opportunity because this shift is, above all, one of learning: learning to function, survive and thrive in new contexts. For educators, learning new ways and new ways of learning are the nature of our profession. Moreover, digital technologies represent a difference in kind of technology. The invention of artificial intelligence (AI) in the 1950s and its rapid growth toward autonomy as a result of massive levels of investment today are creating a new type of technology that does not depend on humans for decision-making or providing marching orders. AI in the form of superintelligence is increasingly capable of outperforming humans in intellectual work and is threatening to become the new *super species* on Earth (Barrat, 2013). The role of educators in understanding the role of thinking as part of the learning process is increasingly urgent. Equally urgent is the need for educators to emphasize their role as professionals, who offer a form of learning that technology alone cannot.

Learning Theory and Online Technologies addresses the need for a theory of learning for 21st-century realities and presents educators with new ways of thinking about teaching and learning using online technologies. This book offers insights into and illuminates the type of learning and communication essential for educational practitioners and researchers today; it is both a guide to and an explanation of new educational practice that considers the ubiquity of online technology in society today.

The book is organized into four main components:

1. Introduction to learning theory and technology (Chapters 1 and 2)
2. Three major theories of learning and technology in the 20th century: behaviorism, cognitivism and constructivist learning (Chapters 3, 4 and 5)
3. Connectivism and collaborativism or online collaborative learning: theories of learning for the 21st century (Chapters 6 and 7). Collaborativism is illustrated by exemplars and cases drawn from formal, non-formal and informal educational settings (Chapters 8 and 9)
4. Conclusions (Chapter 10).

Learning Theory and Online Technologies begins with an overview of learning and technology from a theoretical perspective, exploring the role of learning theory in advancing knowledge. Learning has also historically been linked to technology in human development. Understanding the historical shifts in learning and technology as well as the advances in learning theory during the 20th century provides a valuable framework and context for identifying new theories of learning related to online technologies and social communication.

The second section of the book examines three major theories of learning in the 20th century—behaviorism, cognitivism and constructivism. Each theory introduces a new perspective on what learning is and how it can be facilitated through pedagogies and technologies. Learning theories and technologies reflect the changing view of education in the context of the rapid technological advances of the 20th and 21st centuries. The historical context helps us to understand how education was perceived, shaped and practiced at different stages of human development.

We can also see 20th century learning theories as part of a continuum and as a context for learning theory and practice in the 21st century.

The third section of the book introduces two new theoretical perspectives: connectivism and collaborativism have been associated with learning and teaching in the 21st century. To illuminate collaborativist theory, this section provides real examples of contemporary educational practice based in both blended and fully online environments with learners of all ages, in all settings.

The final chapter concludes with a brief review of the trajectory the book has covered and a preview of future opportunities.

What Is Learning Theory?

A theory is an explanation for why something occurs or how it occurs. Typically, theory is generated by a question or by our curiosity, and offers a response to that question. A theory is an explanation that has been scientifically developed by scientists and scholars using state-of-the-art research methods and information of the day. A theory of learning aims to help us to understand how people learn. Many theories of learning were generated in the 20th century, and in this book we will examine the major theories and how each provided an overview and a guide, or a lens, whereby education professionals (and others) gained a perspective on their field of work. As Albert Einstein stated, "theory provides the framework or lens for our observations." The theory that we employ (consciously or not) determines what we see, what we consider to be important and thus how we will design and implement our practice. By understanding learning theory, educators can reflect on their practice, improve upon, reshape and refine their work, and contribute to advancing the discipline.

Theory should not be viewed as something divorced from how we work as educators or how we understand our professional activities. Theory is integral to practice and vice versa, although not all theoreticians, or practitioners for that matter, have respected and addressed that relationship. Understanding the major theories of learning that emerged in the 20th and 21st centuries and how they were shaped by (and shaped) contemporary technologies and educational practice can help us understand how the field of education has developed and changed. As we will see, theories of learning reflect the times in which they emerged and gained precedence.

A theory is a historical construct and reflects what was possible and deemed necessary and valuable at that time. It is essential that educators understand the context of a learning theory, to understand it as a product of the discourse of that time.

Moreover, theory not only provides ways to see and understand what has happened already or is happening, but is also a means to "envision" new worlds and new ways to work. Theories establish a language and discourse whereby we can discuss, agree, disagree and build new perspectives and ways to become knowledgeable, in this case, in the use of online technologies for learning. In his article "Thoughts on Theory in Educational Technology," Brent Wilson writes:

> Theory helps us formulate ideas; it informs the creative process. When we see the world differently, we act to make things different via the relationship between theory and design or between science and technology. Such relationships allow for new technology or conversely, "… a new technology spawns new theory." (1997a, p. 23)

Theory is also a kind of modus operandi; it influences, shapes and determines our actions, even unknowingly. Whether or not we consciously intend to "operationalize" a particular theory of learning, we are nonetheless operating according to some perspective on how to teach (and concomitantly, even if unconsciously, a perspective on how people learn). As Wilson noted, "Theories shape our world just as surely as physical forces do, albeit in a different way" (1997a, p. 23). Theories shape how we make sense of ideas and information and how we then act.

TABLE 1.1 What is a Theory?

The Role of Theory			
Explains: Why? How? Where? When? What?	Provides: A framework or lens A guide for practice A means to envision change	Shapes: Understanding Discourse Ideas Technology Methodology Actions	The theory we employ (even unknowingly) shapes how we design and implement our practice

Approaches to scientific theory are also competitive. By the 20th century, theoretical approaches became compartmentalized into what can be viewed as two polar opposites: the battle between what is called "scientific" (hypothesis-driven or experimental) theory and "social" or critical theory. Other related theoretical terms include "hard" science versus "soft" social science theories, pure science versus applied science and quantitative versus qualitative scientific research.

This polarization continues to exist but there are increasing attempts to diminish the divide. The growing use of interdisciplinary collaborations in research is reducing some of the separations. Researchers are increasingly employing both quantitative and qualitative methods, especially within online applications. Moreover, while there are differences in what constitutes scientific theory, there are also important commonalities. Theories intend to explain how or why phenomena are understood in a certain way. Moreover, theories are usually linked to observations and are governed by what can be deemed as constituting evidence and reasonable explanation. Theories can also be viewed as a historical snapshot of ongoing discussions and conversations among those committed to the discipline, its study and advancement.

The history of theory development is relatively recent, the product of the scientific revolution that gained precedence in the 19th century. Understanding learning theories as part of this scientific ethos is critical and forms a key undercurrent of this book.

At the same time, theories of learning have an important philosophical component. Thoughts on learning are not new and did not emerge a mere 100 years ago. Reflection on human experience and behavior, its causation and implications, is part of human consciousness. Thousands of

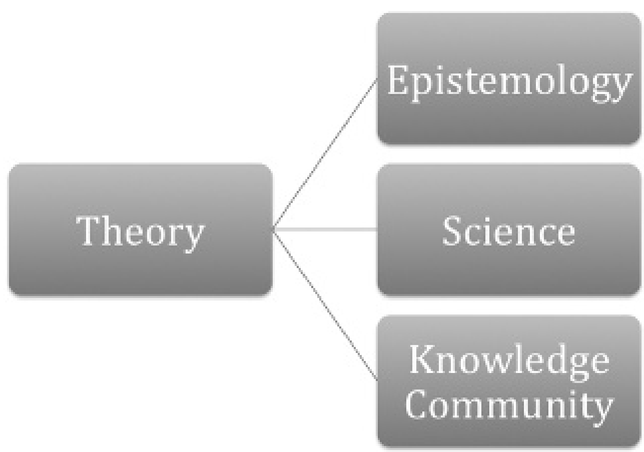


Figure 1.1 Three Aspects of Theory.

years of philosophical, social and religious perspectives on learning preceded the development of learning theories.

The ancient philosophers developed many important and illuminating insights into learning, and contributed to how we view "epistemology" and "knowledge." The term "epistemology" comes from the Greek word *episteme*, meaning knowledge. In simple terms, epistemology is the philosophy of knowledge or of how we come to know.

The discussion of learning theories in this book has an epistemological and a scientific component, and also emphasizes the role of knowledge communities. Knowledge communities are the forums or processes of discourse and debate, whereby scholars advance the state-of-the-art in that discipline. These three terms (epistemology, science and knowledge communities) are discussed below as providing the cornerstones of theory. Deciding what to study when we seek to explain how people learn or deciding how to teach depends upon our disciplinary beliefs and perspectives: theories of learning are based on epistemologies, scientific methods and the views of knowledge communities of the time.

Theory and Epistemology

The term "epistemology," offers a powerful tool for understanding learning theory, and it is a tool that educators should embrace and use in discussing learning theory and how we view teaching and learning. It is an important analytical concept that illuminates a great deal about our field; views of what teaching and learning mean, and how they should be practiced can be viewed as reflecting one of two major scientific epistemologies: objectivist and constructivist. Understanding the epistemology that frames a particular theory reveals important concepts we educators need to understand. Epistemology asks: What is knowledge? How do we know? These questions are important because 20th- and 21st-century learning theories are based on epistemologies that began to nudge the concept of knowledge beyond the view of knowledge as divine that was dominant up until the 19th century. The two major epistemologies of the 20th and 21st centuries are objectivist epistemology (reflected in behaviorist, cognitivist and connectivist theories of learning) and constructivist epistemology (reflected in constructivist and collaborativist learning theories).

Until recently, epistemology in the Western world had a relatively simple foundation: we know because God told us. Kenneth Bruffee, in his book *Collaborative Learning: Higher Education, Interdependence, and the Authority of Knowledge* (1999), writes that up until the time of Descartes (what is called the pre-Cartesian world),

> people tended to believe that the authority of knowledge lodged in one place, the mind of God. Most teachers were priests—or priestly. They derived their authority from what they and their students regarded as their godliness, their nearness to the mind of God. (p. 151)

Formal education was "authorized" by the church, the temple, the synagogue or the mosque. The teachers in ancient civilizations such as Persia and Athenian Greece were to some degree exceptions given their focus on civic laws and virtues. But even civic knowledge was viewed as having a divine origin.

"Post-Cartesian assumptions emerge in roughly the seventeenth century. They remain potent and unquestioned today in the 'cognitive sciences' and implicitly in the persuasion of most members of every other disciplinary community, professional and academic" (Bruffee, 1999, p. 151). These assumptions posit knowledge as existing objectively beyond our own minds, as a kind of finite truth. The implication for education and learning is the search for knowledge and truth, and imparting it to others.

> One kind of knowledge that traditional college and university education especially values because it is long-lasting is knowledge of the conventions of traditional education themselves. Professors are responsible not only for imparting knowledge that was imparted to them, but also imparting knowledge *as* it was imparted to them. (Bruffee, 1999, pp. 152–153)

Eric Mazur, a well-known professor of physics, illustrates this view as part of his own teaching experiences:

> Discussions of education are generally predicted on the assumption that we know what education is … When I started teaching introductory physics to undergraduates at Harvard University, I never asked myself how I would educate my students. I did what my teachers had done—I lectured. I thought that was how one learns. Look around anywhere in the world and you'll find lecture halls filled with students and, at the front, an instructor. This approach to education has not changed since before the Renaissance and the birth of scientific inquiry. Early in my career I received the first hints that something was wrong with teaching in this manner, but I had ignored it. Sometimes it is hard to face reality. (2009, p. 50)

Didactic methods of teaching are the accepted and traditional way of imparting knowledge. Didactic teaching involves transmitting knowledge from the teacher to the student, just as it was earlier transmitted to the teacher when she or he was a student. This is imperative if the view of knowledge is *objectivist*, *foundational* and *absolute* according to Bruffee, who writes that the objectivist view holds that

> knowledge is a kind of substance contained in and given form by the vessel we call the mind. Professors' mental vessels are full, or almost full. Students' mental vessels are less full. The purpose of teaching is to transfer knowledge from the fuller vessels to the less full. (1999, p. 152)

In contrast to the objectivist version of the authority of knowledge is the more recent constructivist epistemology, which holds that knowledge about the world is constructed through our perceptions and interaction and discussion within various communities of knowledgeable peers. Bruffee writes:

> The nonfoundational social constructionist understanding of knowledge denies that it lodges in any of the places I have mentioned: the mind of God, touchstones of truth and value, genius, or the grounds of thought, the human mind and reality. If it lodges anywhere, it is in the conversation that goes on among the members of a community of knowledgeable peers and in the "conversation of mankind." (1999, p. 153)

Bates and Poole (2003) note that the two dominant epistemological positions in North American higher education today are objectivism and constructivism:

> Objectivists believe that there exists an objective and reliable set of facts, principles, and theories that either have been or will be discovered and delineated over the course of time. This position is linked to the belief that truth exists outside the human mind, or independently of what an individual may or may not believe. (pp. 27–28)

On the other hand, constructivist epistemologies hold

> that knowledge is essentially subjective in nature, constructed from our perceptions and usually agreed upon conventions. According to this view, we construct new knowledge rather than simply acquire it via memorization or through transmission of those who know to those who did not. (Bates and Poole, 2003, p. 28)

Epistemologies of knowledge are key to how we view and how we practice teaching and learning. An educator operating from an objectivist epistemology is "far more likely to believe that a course must present a body of knowledge to be learned" (Bates and Poole, 2003, p. 28). The objectivist epistemology underlies the didactic approach to teaching, based on the belief that students learn passively by receiving and assimilating knowledge from others. The student is required to generate the correct answer, reflecting back the information first transmitted by the teacher. The teacher must ensure that the information to be transmitted is structured, authoritative and organized in particular ways to enable the student to acquire and repeat it "correctly." Objectivist epistemology underlies two of the major learning theories of the 20th century, behaviorism and cognitivism, discussed in Chapters 3 and 4.

The term "constructivism" refers to both an epistemology and a theory of learning. Constructivist epistemology holds that knowledge is constructed from our perceptions and our interpretations based upon contemporary conventions. Our perceptions are shaped through interactions with others, in particular with more knowledgeable peers and/or the appropriate knowledge community. The constructivist epistemology is reflected in both the constructivist and collaborativist learning theories, discussed in Chapters 5 and 7.

Theory and Scientific Method

While philosophies of learning have been a recurrent theme and concern since the time of ancient civilizations, theory and scientific methods first emerged in the 19th century under the influence of *positivism*, a term coined by the French philosopher, Auguste Comte, in 1847. Comte (1798–1857) was the first intellectual to systematically articulate positivism and to present empirical method as a replacement for metaphysics or theism in the history of thought. Until then, metaphysics was the dominant view, emphasizing that a divine world lies beyond experience, and transcends the physical or natural world. Theism refers to belief in the existence of one or several gods who intervene in the lives of humans. Comte rejected metaphysics and theism, arguing that a rational assertion should be scientifically verifiable, that is, demonstrated by empirical evidence or mathematical proof. Theory was an assertion or observation linked to science; the purpose of science, Comte argued, is to observe and measure phenomena that we experience and can directly manipulate. Comte believed that empiricism should be at the core of scientific endeavor and that formal experiment was the key to scientific method. Since emotions and thoughts were not directly observable, they were not accepted as legitimate areas of study and were viewed as irrelevant by positivist science. Positivism holds that theology and metaphysics are imperfect modes of knowledge, whereas positive knowledge is based on natural phenomena with properties and relations verified by empirical science. Theory must therefore be verifiable by empirical science.

The first theories of learning can be traced to the late 19th century, related to the emergence of positivism and scientific inquiry. Whereas "philosophies" of learning deal with values and worldviews, "theories" of learning emphasize an empirical element and a formalized way of study, analysis and conclusion. It is this distinguishing quality of theory, its empirical nature, that remains relevant today, although the rigid aspect of positivism that restricted the study of learning to observable behavior is less accepted by educational researchers.

Theory and Knowledge Communities

Knowledge communities refer to scholarly groups associated with a particular field or related to a discipline. It is the work of the members of a knowledge community to define the state-of-the-art and to advance that state in a particular discipline or field of work. Scholarly or knowledge communities are associated with all scientific, cultural and artistic fields of endeavor. Other terms used to describe this concept are knowledge societies, scientific communities, invisible colleges and schools of thought. The concept itself, however, is key because theory building is typically conducted by and within the context of a particular knowledge community. Members collaborate and argue, agree and disagree and introduce new information and empirical data to contribute to and advance knowledge in the field. Scardamalia and Bereiter (2006) write:

> In every progressive discipline one finds periodic reviews of the state of knowledge or the "state of the art" in the field. Different reviewers will offer different descriptions of the state of knowledge; however, their disagreements are open to argument that may itself contribute to advancing the state of knowledge. (p. 100)

Knowledge creation is a deliberate process of advancing the frontiers in a particular discipline. Knowledge is thus viewed as constructed through informed dialogue and conversations conducted among members of a knowledge community.

Academic, cultural, scientific and professional knowledge communities share commonalities or integrative beliefs. Kuhn (1970), whose writings on the structure of scientific revolutions (also called paradigm shifts) are considered to be intellectual landmarks explaining the process of discovery, examined the nature and role of scientific communities. He asked: "What do its members share that accounts for the relative fullness of their professional communication and the relative unanimity of their professional judgments? … Scientists themselves would say they share a theory or set of theories" (Kuhn, 1970, p. 182).

> Knowledge communities are scientists or leading thinkers gathered or clustered around a theory and represent the state-of-the-art in that discipline. A particular knowledge community represents the theory of the discipline, how it is defined and articulated in practice, and how it is substantiated.

The concept of knowledge communities is key in this book. The five major learning theories discussed here represent the state-of-the-art as articulated by particular knowledge communities, which flourished at particular points in time. Theories exist in context, and both reflect and illuminate that context. Theories change and improve over time. Knowledge in a field does not merely accumulate, it advances. The next section introduces the theories of learning in the 20th

TABLE 1.2 Historical Views on Knowledge

Metaphysical	*Scientific*
• Belief in the sole authority of God and religion • Knowledge is Godliness (proximity to God's mind)	• Belief in the authority of empirical evidence to enable knowing • Knowledge is what we can sense, discuss, study and improve

and 21st centuries, and briefly discusses the essence of each theory and how it evolved within the social context of its time.

Learning Theories of the 20th Century

Learning theories emerged in the 20th century, with three major theoretical frameworks shaping the study of learning:

- behaviorist learning theory;
- cognitivist learning theory;
- constructivist learning theory.

This book explores the major aspects of these theories, and the pedagogies and technologies associated with each. The use of a historical approach also illuminates the development of how we understand learning theory and technology, especially with respect to education today.

The major theoretical frameworks are thus viewed along a historical continuum, reflecting how human study and understanding of learning have developed and advanced over the past 100 years. These theories ought not to be considered as distinct silos—independent or autonomous of one another. Indeed, theorists associated with one particular theory may also have contributed to the development of other theoretical frameworks. A particular researcher may have been at the cutting edge; writing at a time of transition and exploration of new ideas, his or her writings may thus reflect different theoretical perspectives, some of the old and some of the new. For example, Robert Gagné, an educational psychologist widely recognized for his contribution to instructional design, was linked to both behaviorism and cognitivist theories of learning: "Gagné's (1985) conditions for learning underwent development and revision for twenty or more years. With behaviorist roots, it now brings together a cognitive information-processing perspective on learning with empirical findings of what good teachers do in their classrooms" (Driscoll, 2005, p. 352). Nor should a theory be viewed as providing a complete or finite answer to a knowledge problem; it is a step on the path to better understanding. Theoretical frameworks of learning are a dynamic and fluid part of knowledge, improving with new research and also with the new technologies that emerge and transform intellectual, social and economic horizons. Ideas improve and knowledge advances. The development of learning theory in the 20th century can be viewed as evolving, improving upon preceding schools of thought as scholars engaged in discussion, debate, conversation and responded to new information, ideas and technological opportunities.

> If research programs are going well, then occasional challenging results are either quietly ignored, called interesting phenomena to be shelved for later study, or explained away. Only when an alternative view emerges, as cognitive theory emerged in the 1960s to rival behavior theory, do old problems appear significant. (Leahey & Harris, 1997, p. 44)

Change, moreover, is not a smooth process: it represents shifts and breaks in tradition. This is the case with the development of learning theories. Kuhn (1970) referred to the growth of intellectual creativity and progress as paradigmatic shifts and revolutions. Theories are products of their time and the transition from one theory to the next is based on discussion, debate and intellectual struggle as scholars try to make sense of particular knowledge problems with the information available at the time. Intellectual progress is a road of endless conversation and ongoing challenges. New theories are called epistemological breaks but also breakthroughs.

Hence the metaphor of a continuum or evolution (or, in Kuhn's terms, a revolution) of ideas of learning is arguably essential to the study of learning. We continue to study and learn about how people learn; theories should be viewed as building upon (and reacting to) one another, enhancing and advancing our knowledge. We might think of spirals of knowledge, aggregating, advancing and improving over time. At the same time, it is essential to recognize and understand the assumptions that characterize each learning theory, and how learning was understood and organized at that time.

Behaviorist Learning Theory

Behaviorist learning theory focuses on that which is observable: how people behave and especially how to change or elicit particular behaviors. Behaviorism provided a theory of learning that was empirical, observable and measurable.

Developed in the late 19th century, behaviorism was the first major theory of learning and represented a radical leap forward in terms of human science. Scientific method was still in its earliest days. The introduction of Comte's notion of positivism represented a very profound shift in thinking; scientific method challenged and replaced metaphysics in the history of thought. Hitherto, for millennia, metaphysics and divine intervention had been accepted as the cause of all social, human, physical and biological phenomena.

Behaviorism was one of the first examples of the use of scientific method to explain human action, psychology and learning, offering an explanation that could be empirically verified. Behaviorism introduced a way to study and to shape learning that could be repeated and replicated.

Looking back, we can see that behaviorism was limited and rigid in its perspective. But for its time, behaviorism was hailed as a breakthrough in its ability to study, measure and replicate the same results, time and again. This was a first and by no means modest achievement. Behaviorism, as one of the first positivist approaches to human sciences, was by necessity very narrow in its focus. It was a new approach and sought membership in the positivist scientific community. Behaviorism limited its lens to that which could be observed, emphasizing overt action as being most easily apparent and accessible for study. The term "overt action" refers to behavior; in other words, behaviorism focused on how we act and what impacts upon and changes how we act. Behaviorists limited their consideration to stimulus and response: a particular act stimulated a certain reaction, a response that could be observed, repeated and quantified. In this theory, there is no notion or consideration of thought processes in the mind—the mind is viewed as a black box, largely irrelevant.

Ivan Pavlov (1849–1936) is considered the intellectual founder of behaviorist learning theory. He is famous for his theory of classical conditioning. Burrhus Frederic Skinner (1904–1990) is also famously associated with behaviorist learning theory, but Skinner's work differed from his Pavlovian predecessors in that he focused on what is referred to as voluntary or operant behavioral conditioning, a behaviorist approach different from classical conditioning.

Behavioral learning theory lent itself to instructional design based on very specific and discrete learning steps. And also, very importantly, it led to the mechanization of this instructional process through new forms of learning technologies such as teaching machines, programmed instruction, computer-assisted instruction (CAI) and, eventually, courseware and massive open online courses (MOOCs).

Behaviorist learning theory is the focus of Chapter 3.

Cognitivist Learning Theory

Limitations in the behaviorist framework of learning began to be recognized in the early 1920s. The major problem for researchers was that behaviorism was unable to explain most social behaviors. For behaviorist scientists, what you cannot see or measure does not count. Behaviorists would consider only what they could see and the ability to measure what was seen.

Yet, as researchers and psychologists involved in the scientific study of learning began to realize, the power of the mind to influence or make decisions that are not directly related to an external stimulus was highly significant. The mind did play a tremendous role, even if we could not "see" it.

If behaviorism treated the mind as a black box, cognitive theory recognized the importance of the mind in making sense of the material world. Cognitivism sought to understand what was inside the black box of the mind, in order to emulate it computationally. Cognitivist learning theory was particularly influenced by the rise of cognitive science, the invention of the computer in 1946 (the Eniac) and the emergence of computer science. The mind became viewed as a computer: a powerful metaphor that characterized this approach was "mind as computer" (MAC). The model of students mentally processing information (just as computers processed information) is referred to as cognitive information processing (CIPs) and is a major theme in cognitivist learning theory.

Cognitivism was concerned with technology that could model the mind and represent knowledge, and cognitive scientists sought to develop educational technologies such as intelligent tutoring systems (ITS) and AI in an attempt to mimic or replicate the human mind through computer programs. Cognitivism, while a learning theory distinct from behaviorism, nonetheless also presupposes that the primary role of the learner is to assimilate whatever the teacher presents. Cognitive pedagogy, like behaviorist pedagogy, employed a didactic model of teaching: the cognitivist pedagogy was based on objectivist instructional design.

Cognitivist learning theory is the subject of Chapter 4.

Constructivist Learning Theory

Constructivist theory refers to a theory or set of theories about learning that emerged, in part, in reaction to behaviorism and cognitivism. Constructivism emerged during a period of educational reform in the United States and was influenced by new constructivist psychological research and trends in Europe, which emphasized the role of the individual in making sense of the world. Educational researchers and practitioners came to realize that humans could not be programmed, as robots are, to always respond in the same way to a stimulus. In fact, constructivists argued, the mind plays an enormous role in how people act when learning. And that role is not directly comparable to a software program based on discrete steps to consume and process information. Constructivism—particularly in its "social" forms—suggests that the learner is much more actively involved in a joint enterprise with the teacher and peers in creating (constructing) meaning.

Constructivism refers both to a learning theory (an empirical explanation of how people learn) and to an epistemology of learning (a view of the nature of knowledge). They are not identical terms, however. The constructivist learning theory explains how learners construct meaning. The constructivist epistemology refers to a philosophical view that knowledge is constructed through our interactions with one another, the community and the environment, and that knowledge is not something absolute.

The constructivist theory of learning holds that people learn by constructing their own understanding and knowledge of the world through experience and reflecting upon that experience. We are active creators of our own knowledge, reconciling our previous ideas as we encounter new experiences and information. We may change our ideas or discard the new information based on our investigations, asking questions and assessing and negotiating what we know with others.

In the 20th century, the major psychologists and educators associated with constructivist approaches to teaching and learning were Jean Piaget and Lev Vygotsky.

Constructivist learning theories, pedagogies and technologies are examined in Chapter 5.

Learning Theories for the 21st Century

Connectivism and Collaborativism (Online Collaborative Learning Theory)

The three major theories of learning that emerged during the 20th century (behaviorism, constructivism and cognitivism) derived from the field of educational psychology. Robert Calfee's (2006) article, "Educational Psychology in the 21st Century," identifies four key omissions or problems with 20th-century educational psychology that need to be addressed by theory in the 21st century:

> First, educational psychology continues to struggle with the most appropriate relation to *practice*…
>
> Second, the position of *adults* in educational psychology remains a puzzlement…
>
> Third, neither HBEPI nor HBEPII include "*Learning*" in a chapter title!…
>
> A fourth and final set of issues centers around *methodology*. (pp. 30–31, emphasis added)

These four problems with 20th-century educational psychology reflect problems in 20th-century theories of learning, which need to be addressed in contemporary theory development.

> Other than electrification, today's classroom is remarkably unchanged from the end of the 19th century. The cast of characters and the activities remain virtually unchanged, along with the length of the school day and year and several other parameters. Schools have thwarted numerous innovations; radio, television, and even telephones have minimal presence in today's classrooms. Systems that we take for granted outside the school walls—computers, the Internet, PDAs, handhelds—are either somnolent or prohibited. (Calfee, 2006, p. 35)

These issues call for new learning theories to be linked to practice and to real-world contexts and technologies.

Behaviorist, cognitivist and developmental constructivist theories of learning emphasized learning as an individualistic pursuit. Moreover, the epistemological basis of behaviorism and cognitivism was objectivism: objectivist epistemology holds that knowledge is fixed and finite and, ultimately, that knowledge is truth. Knowledge is something that the teacher has mastered, and which students must now similarly master by replicating the knowledge of the teacher. The pedagogies emphasized "transmitting information" by the teacher as a way to "acquire knowledge" by the student, reflected in such didactic approaches as lectures or their mechanized versions in the form of teaching machines, CAI, ITS and courseware. This was the ethos of the Industrial Age, an era that emphasized the learner's ability to acquire and retain information and associated skills. An implicit educational goal was that the student should learn to follow instructions accurately to achieve the desired result.

The invention and widespread adoption of the internet together with the rise of AI has created very new scenarios in society, at a global level. Online digital technologies are creating new intellectual, social, economic and cultural mindsets. Whereas the Industrial Revolution extended and leveraged our physical capabilities to manipulate objects far beyond muscle power alone, the Internet Revolution is tackling human cognitive abilities, some seeking to extend and leverage human intelligence, while others seek to replace or reduce human knowledge work as well as physical work. AI, artificial intelligence, has become a powerful new commercial agent and presence in all our computer and mobile devices, constantly monitoring and collecting data on human activities in order to change behavior for commercial or other interests. AI is based on the concept of the computer as an autonomous force, and reflects an objectivist epistemology. However, in the early 1950s, while computer pioneers such as Marvin Minsky sought to replace human labor and cognition with powerful computing, other pioneers such as Douglas Engelbart and Ted Nelson sought to augment human intelligence, not automate, reduce or replace it. This trend is referred to in this book as AHI (augmented human intelligence). AHI reflects a constructivist epistemology.

Two theories of learning for the 21st century are discussed: connectivism in Chapter 6 and collaborativism in Chapter 7. As with learning theories of the 20th century, connectivism and collaborativism build upon previous approaches, but present a new perspective. Both are associated with the invention of computer networking and the internet, and the concomitant socio-economic shift from the industrial society to the Knowledge Age.

In 2004, connectivism was pronounced "the" learning theory for the digital age by its proponents, George Siemens and Stephen Downes. They argued that learning is a process of connecting with nodes of information and that learning resides not only in the human learner but also in non-human appliances; moreover, the role of the teacher in shaping a curriculum and organizing the course is better accomplished by intelligent networks. Stephen Downes wrote in 2007 that computer networks would organize resources for learning "*without prejudice (or commercial motivation)*" (Downes, 2007c, emphasis added). A self-organizing network would

> never need to be searched – *it would flex and bend and reshape itself minute by minute according to where you are, who you're with, what you're doing, and would always have certain resources*

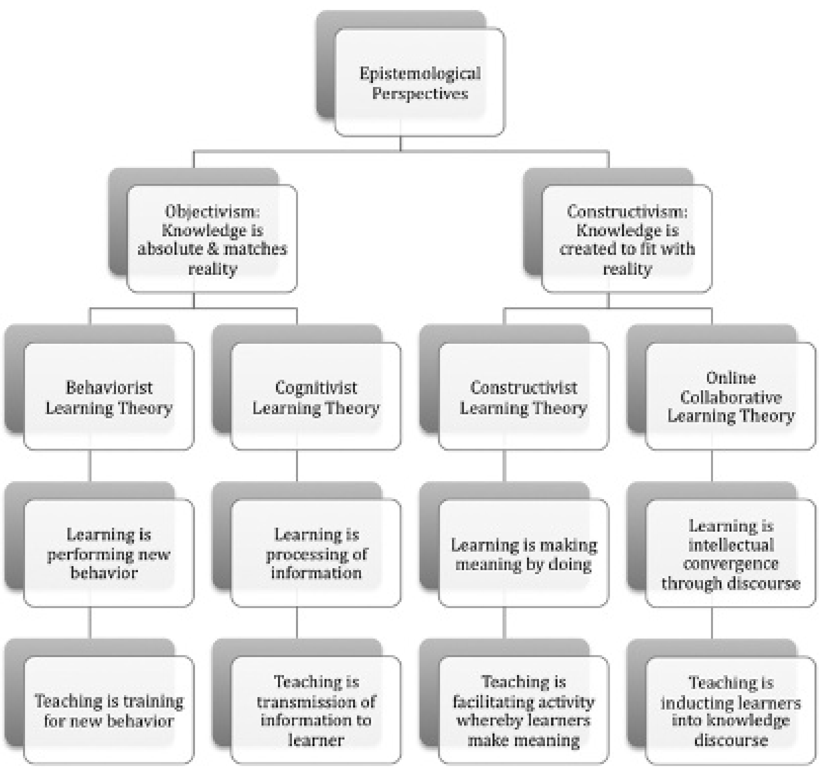


Figure 1.2 Epistemological Perspectives on Learning Theories.

> *"top of mind" would could [sic] be displayed in any environment or work area.* (Downes, 2007c, emphasis added)

Collaborativist learning theory, previously known as online collaborative learning or OCL, provides a framework to guide understanding and practice of education in the Knowledge Age. Unlike the behaviorist and cognitivist emphasis on instructions for replicating a textbook answer, collaborativism focuses on knowledge-building processes. Collaborativist theory differs from constructivist learning theory by locating active learning within a process of social and conceptual development based on knowledge discourse.

> One important advantage of knowledge building as an educational approach is that it provides a straightforward way to address the contemporary emphasis on knowledge creation and innovation. These lie outside the scope of most constructivist approaches, whereas they are at the heart of knowledge building. (Scardamalia & Bereiter, 2006, p. 99)

Collaborativism provides a learning theory and pedagogy that addresses 21st-century needs and opportunities. As discussed in Chapter 7, collaborativist theory is grounded in educational practice and focuses on learners of all ages as participants in 21st-century online knowledge communities, whether in formal, non-formal or informal educational settings. Chapters 7, 8 and 9 explore examples of collaborativism in practice.

Summary

Chapter 1 addressed the current challenges of teaching and learning in an increasingly online world, in particular the need for learning theories that can speak to and guide education in this context. It explored the definition, importance and role of a theory of learning in general, and discussed how learning theory is based on key concepts such as epistemology, scientific method and knowledge communities.

Chapter 1 revealed that the rise of learning theories was relatively recent; theories of learning, as with most scientific theories, first appeared toward the end of the 19th century and early in the 20th century, as part of the emergence of modern science and scientific method. Learning came under the scrutiny of scientific study around the same time that topics related to human and natural behavior came to be studied and organized within the framework of "theory." During the 20th century, scientific learning theories were articulated, built upon and gained increasing importance in the study and practice of education. Three major learning theories influenced education in the 20th century: behaviorism, cognitivism and constructivism. These learning theories are also each associated with particular learning pedagogies and learning technologies. Two theories of learning for the 21st century, collaborativism, previously known as online collaborative learning or OCL, and connectivism, are also introduced. These five learning theories are each explored in subsequent chapters.

As Chapter 1 has introduced and Chapter 2 will expand on, learning and technology have been intertwined with one another throughout human history. Together, new learning needs and new technologies have contributed to major social and civilizational shifts, as discussed in Chapter 2.

2
Historical Overview of Learning and Technology

> We propose that the crucial difference between human cognition and that of other species is the ability to participate with others in collaborative activities with shared goals and intentions.
>
> **—Tomasello, Carpenter, Call, Behne, & Moll, 2005**

Chapter 2 covers the following topics:

- Introduction to history of learning and technology
- Steps in human development
    - Speech
    - Writing
    - Printing
    - Internet
- The invention of the internet as a meeting of minds
- The internet and its social applications
- Historical overview of online learning
    - Adjunct mode online learning
    - Blended or mixed-mode online learning
    - Totally online learning.

Introduction

Chapter 2 explores the fascinating story of how learning and technology have been integral to human development from our earliest human ancestry. Technology has enabled communication and, linked with our most human characteristic of intentional collaboration, is essential to human learning and development. This chapter explores the role of learning and technology, focusing on specific historical developments that revolutionized our communication and expanded our knowledge-building capacities, from the time of our pre-linguistic and prehistoric ancestors until the present Knowledge Age.

Steps in Human Development: Learning and Technology

Our human ancestors, whether hunters and gatherers eking out survival with family and clans in caves or members of ancient civilizations who built city states and engaged in commerce, were profoundly different in many ways from today's societies. Nonetheless, we all share the basic need to survive and advance: learning, communication, collaboration and the creation of tools are the fundamental mechanisms that enable human society to survive and progress. Chapters 3, 4, 5, 6 and 7 will each focus on a particular theory of learning and discuss the pedagogy and technology associated with it. Chapter 2 provides a basis for this discussion by providing an overview of how learning and technology have been interconnected throughout human history and are key to social and civilizational advancement.

The need and ability to learn (and hence to educate effectively and efficiently) is at the root of human survival and civilization. Since prehistoric kinships, humans have addressed the need to survive and thrive through learning and teaching their young and one another by inventing new learning technologies. And we have done so collaboratively and collectively. In fact, evolutionary biologists today propose that the dividing line between humans and other species is the ability to *intentionally* participate in collaborative activities.

Traits that anthropologists once believed separated humans from other great apes, such as tool-making, walking, hunting cooperatively and fighting wars, have all been found to exist in other species. Sarah Hrdy, a renowned evolutionary anthropologist, writes that it is intentional collaboration, along with our extra-large brains (relative to our body size and compared to other species) and capacity for language, that marks the dividing line for human behavior, separating our nature from that of other apes (2009, p. 9). Michael Tomasello, leader of the Max Planck Institute of Evolutionary Anthropology, writes that "human beings, and only human beings, are biologically adapted for participating in collaborative activities involving shared goals and socially coordinated action plans" (as cited in Hrdy, 2009, p. 9). Collaboration is the key to our survival and to cultural and human development and knowledge.

Hrdy goes on to explore collaboration as the basis for human development:

> Unlike chimpanzees and other apes, almost all humans are naturally eager to collaborate with others. They may prefer engaging with familiar kin but they also easily coordinate with non-kin, even strangers. Given opportunities, humans develop these proclivities into complex enterprises such as collaboratively tracking and hunting prey, processing food, playing cooperative games, building shelters, or designing spacecraft that reach the moon. (2009, p. 10)

Collaboration is a key characteristic of human development, reflected in all our survival and civilizational activities from raising our young to collaboratively gathering food to building spacecraft. The major stages in human development are referred to as paradigmatic shifts: major changes in society, learning, technology and knowledge.

Human social development is the result of key civilizational shifts throughout history. These civilizational shifts (also known as paradigmatic shifts) refer to the major transformations that occurred as technological breakthroughs came together with changing cultural, social and economic conditions to create new contexts, opportunities and challenges.

In both prehistoric and historic periods, technology breakthroughs and new social formations have combined, each influencing the other and thus establishing new lifestyles that, in turn, impacted on each successive generation and society. They are turning points, milestones in human development. Scientists generally identify four major paradigmatic shifts, although the names for these shifts may vary.

A general and condensed chronology of these major socio-technological shifts includes:

- Speech (40,000 BCE): the development of speech and intertribal communication in hunter–gatherer communities produces recognizable civilizations based on informal learning with characteristic crafts and symbolic art.
- Writing (10,000 BCE): agricultural revolution interacts with the massing of populations in fertile regions to produce state structures and cumulative knowledge growth based on the invention of writing and the formalization of learning.
- Printing (CE 1600): machine technology and the printing press interact with the development of global trade and communication, to expand the dissemination and specialization of knowledge and science.
- Internet (CE 2000): advanced network technology interacts with powerful new models of education and training that offer the potential to produce knowledge-based economies and the democratization of knowledge production.

In the 21st century, educators ponder current practice, new technologies and how to address the gap between the two. Scenarios for new learning technologies and practices are explored in

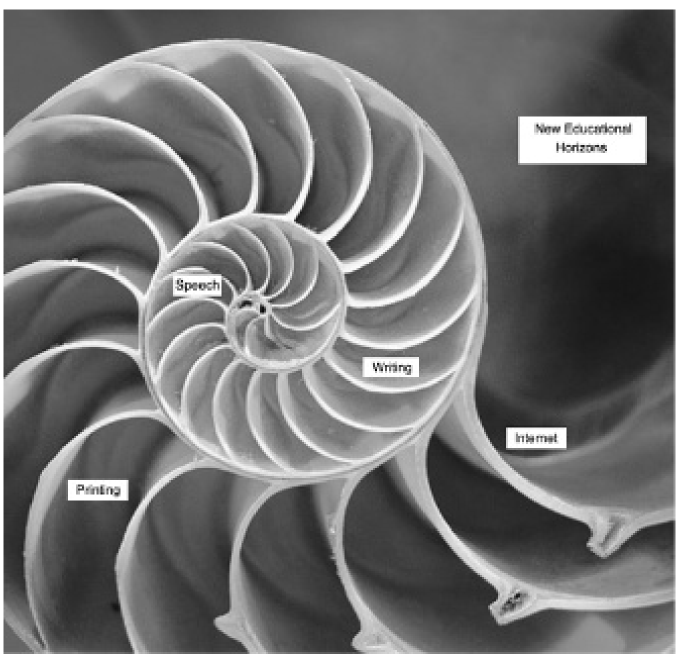


Figure 2.1 Four Communication Paradigms.

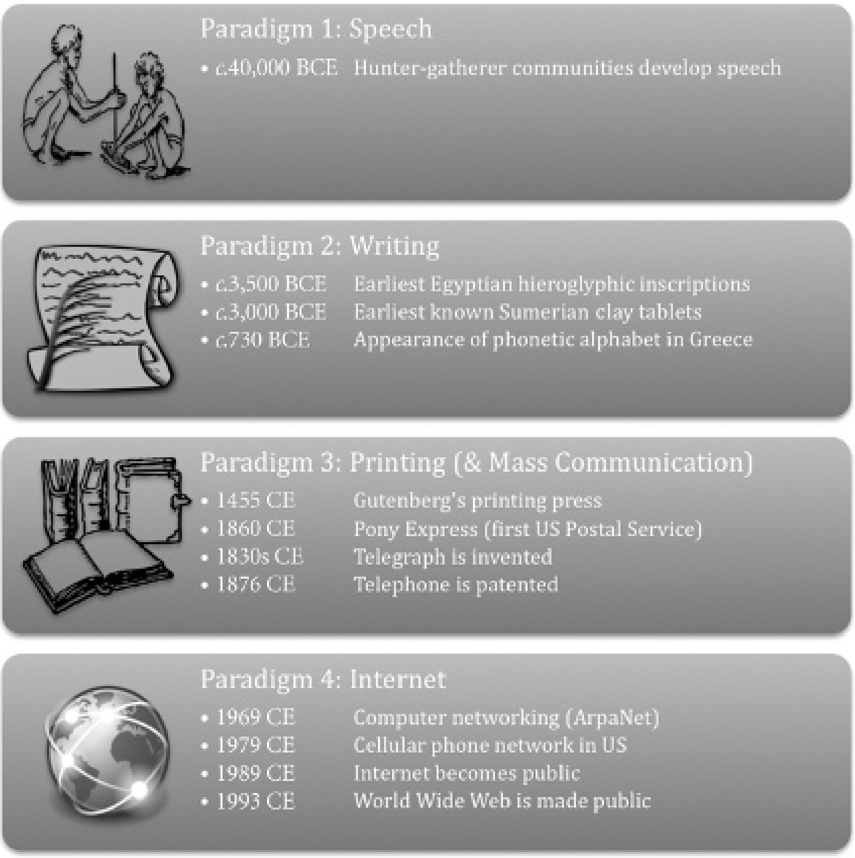


Figure 2.2 Technological Milestones Within the Four Communication Paradigms.

Chapters 6–10. Yet, the history of how we navigated our way to the present is also important. This history tells the story of how human learning has been linked with technology, communication and collaboration. It is important to our understanding of learning in general and also to frame our study of learning theory in the 20th and 21st centuries.

The next section provides a brief synopsis of this history, exploring the paradigmatic shifts representing major leaps in learning and technology.

Each shift represents an advance to a new level of knowledge.

Paradigm 1: Speech

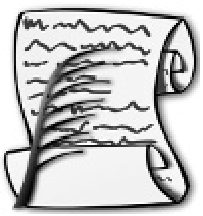
- 40,000 BCE: the development of speech and intertribal communication in hunter–gatherer clans produces recognizable civilizations with characteristic crafts and symbolic art.

As with children today, the newborn in hunter–gatherer communities began to learn within the context of the mother and the surrounding clan and community. Since earliest prehistory, humans learned from observing and imitating the behavior of others.

Our prehistoric ancestors also developed new technologies to assist in personal and communal survival, in this case communication technologies using the human voice. Speech evolved from grunts, shouts, noises and whistles intended to signal an event or emotion, for example, distress, warning, threat, need, pleasure and pain. Prehistoric speech and language were forms of codified communication: what is good or bad; what to do or not do; who should do it, and when, how and where to do it; and, eventually, why to do it, either for cultural or survival purposes. While this period is often characterized as the Stone Age and it is true that advanced tool-making based on stone is a key characteristic, most importantly this is the age of speech—the most profound technology invented by humankind.

In prehistoric societies, children learned both by observation and mimicry, as well as from the "technology" of oral education provided by their mothers and the clan. Speech also meant that the communal history of knowledge, beliefs, culture and skills could be passed from one generation to the next. This early stage in the technology of language enabled "oral histories" to pass from one person to another, generation to generation, through stories, legends, rituals and songs. Wall drawings were created to illustrate or instruct, and enhance oral traditions. Language and illustration were important tools for sharing, archiving and transmitting information and knowledge.

Paradigm 2: Writing



- 10,000 BCE: the agricultural revolution interacts with the massing of populations in fertile regions to produce state structures and cumulative knowledge growth based on the invention of writing and the formalization of learning.

The term "agrarian revolution" refers to the transition from bands or communities of hunters and gatherers that characterized our earliest ancestors to that of an agriculture-based economy and society. Whereas hunters and gathers were constantly on the move to track herds of animals and adapt to the seasons to harvest grain, fruit, nuts and roots, the development of agriculture made human settlement (or semi-settlement) possible. The domestication of animals and cultivation of plants enabled a more stable lifestyle and settled society, as compared to living hand-to-mouth to survive, which required a far greater expenditure of time and energy.

The process of producing and harvesting food, the increased yield of crops and the reliability of access to such essentials had an immense social and economic impact on these communities. With more stable living conditions, these early communities had the time and energy to learn new skills. They became more proficient in trading and the structure of their communities became more complex; they established trading economies, privatization and social, economic and political stratification. All of this contributed to a continuous development of culture, knowledge and new technologies.

The technology of writing—numeracy and literacy—evolved during this period. Numeracy (a system of counting and recording numbers) and literacy (a system of writing letters and/or words) developed as a result of the surplus of food and goods derived from domestic production and trade. Storage and trade of goods required a form of recording, and writing solved the need for ways to count and to describe items held, received or distributed, as well as designating ownership. Literacy was, at its most basic, a method for record keeping. It is believed that characters used for communication emerged approximately 3,500 BCE in various agrarian civilizations and are linked to the development of surplus yields and private ownership. The original Mesopotamian writing system was derived from a method of account keeping and by the end of the fourth millennium BCE had evolved into a triangular-shaped stylus pressed into soft clay for recording numbers. Around the 26th century BCE cuneiform began to represent syllables of spoken Sumerian and became a general purpose writing system for logograms, syllables and numbers. The world's oldest alphabet was developed in central Egypt around 2,000 BCE from a hieroglyphic prototype (Martin, 1994).

The increased organization and specialization of society required changes in how and what people learned. The majority of the population continued to learn through mimicry and apprenticeship: this included observation, hands-on training and experience by trial and error. Eventually, however, formalized learning emerged among settled populations.

Formalized learning was "invented" as a way of teaching a select group of people who had been chosen to serve in matters of importance, such as tasks related to money or religion. These early societies required workers who possessed literary and numerical skills to guarantee accuracy and accountability. Instructors ensured that their curricula were recorded, maintained and updated and that the learning outcomes were assessed. Such formalized education eventually became the basis of schooling as we know it today.

Formal learning in these early societies focused on the skills of writing, reading and counting, but also on civil behavior appropriate to the students' socio-economic standing. Formal education was based on exclusivity. Only people from privileged backgrounds were allowed to learn the skills to become scribes or officials for political, religious, economic or military service. Through prescribed learning, these people were socialized to be upstanding citizens and followers of the faith.

In 580 BCE, Xenophon, popularly known as the first historian, wrote about learning and Persian laws. He explained that in Persia men are educated to avoid lawless behavior and that formal education served a preventative purpose. In Persian society, special areas of the royal court were set aside for learning. This was a very early form of school.

Formal learning can also be traced back to the Greek philosopher, Plato (427–347 BCE), who founded the Academy in Athens, regarded as the first institute of higher learning in the Western world.

The history of writing is fascinating and of profound interest in understanding communication and human progress throughout the ages and to the present. According to H. J. Martin, "All writing is tied to the form of thought of the civilization that created it and to which its destiny is linked" (1994, p. 15). The history of writing is beyond the scope of this book, however, except to provide the context and framework of the integral links between writing, language, thought and knowledge. Writing enabled knowledge to be communicated. It could be disseminated to others, near and far, and hence not only transmit ideas but contribute to ongoing discussion, debate and knowledge building. Writing also enabled knowledge to be archived and hence disseminated historically: future generations could read the prevailing thoughts and ideas, and thereby learn from and add to the cumulative body of human knowledge. Writing is the basis of formal learning.

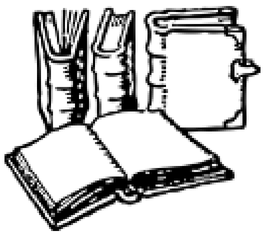
The first known writing is believed to have developed around 2300 BCE in Mesopotamia. Writing spread to Crete during the period around 2000 BCE, and by the 9th or 8th century BCE, the

Greek alphabet—the ancestor of modern European alphabets—appeared (Martin, 1994, p. 34). In all of its varieties and instantiations, whether in the ancient Middle East, China or pre-Columbian America, writing emerged and was revered as communication with the deities.

Similarly, Roman Papal doctrines were thought to "hold the word of God"; they were considered divine and sacred and therefore not to be seen by or communicated directly to the common man or woman, but represented by the church and its few literate priests. Furthermore, all sacred documents were written in Latin, a language not understood by the common person. Reading and writing were skills reserved for a very select few.

However, the power of the written word—4,000 years after its invention—was about to be unleashed. In 15th century Europe, the printing press (and related technologies such as paper) was about to be invented.

Paradigm 3: Printing (and Mass Communication)



- CE 1600: machine technology and the printing press interact with the development of global trade and communication, creating the specialization of knowledge production and science.

Arguably, the most famous "learning technology" of the third paradigm was the invention of printing. Johannes Gutenberg (1398–1468), a German printer and goldsmith, invented movable type and the mechanical printing press around 1439. He is also known for printing the Gutenberg Bible: approximately 180 copies were published in 1455.

The invention of the printing press was a technological innovation with tremendous implications for Western society, in that it provided a means for disseminating ideas not only about religion, but also science, education and politics. The printing press enabled books, such as the Bible and others, to be printed in larger numbers and for less cost than handwritten, manuscript versions previously available only to the Church and the elite. For the first time in history, commercial mass production of books was possible. Printing made books more economical to produce and wider segments of the population could afford them. Publishing allowed people to follow debates, take part in discussions and learn about matters that concerned them. One early example is pamphlets on the plague that taught people how to deal with this illness.

Gutenberg's printing press revolutionized learning and knowledge transmission in Europe to an unprecedented degree: pamphlets, booklets and complete books could now be efficiently and cost-effectively produced and disseminated.

Printing spread widely and rapidly across Europe and by the end of the 15th century the number of books produced on presses like that designed by Gutenberg reached the hundreds. The rapid spread of publishing was a major factor contributing to the Renaissance, the Scientific Revolution and the Protestant Reformation. Martin Luther's *95 Theses* was nailed to the doors of the Castle Church in Wittenberg, Germany in 1517 (though this claim is debated) and was subsequently printed and widely circulated. The production of more books and the propagation of ideas to a wider audience fueled new ways of understanding, as well as influencing a significant shift in Western thought. Importantly, the broadsheet format of Luther's *95 Theses* and its circulation became a prototype for newspapers and mass media today.

The production of printed books and other reading materials provided a motivation for the public to learn to read and seek formal education. The availability of reading materials meant more people did learn to read and expand their knowledge on a wide range of topics.

The momentum toward public access to information and knowledge was unstoppable once books became more widely available. By 1465, the printing press in Europe led to the rapid growth of printed materials and the dissemination of information to an eager public.

> There were more than 250 centers of the print trade by 1 January 1501, the fatal moment after books, now out of their cradle, are no longer called incunabula. The estimated 27,000 known publications certainly represent more than ten million copies, circulated in less than two generations in a Europe whose population was under a hundred million. This would give a maximum of some few hundred thousand confirmed readers. (Martin, 1994, p. 227)

The relationship between learning and technology is again illuminated: the base of knowledge created with the development of speech, expanded through writing, is now further advanced as publishing creates and responds to new learning needs. The rise of machine manufacturing and industrialization in the 18th, 19th and 20th centuries is integrally linked with a need for mass literacy techniques and technologies. Mass communication intensifies the need for mass education. With the rise of modern science, new theories of learning emerged in the 20th century to address the Industrial Age.

Paradigm 4: Internet

- CE 2000: advanced information technology interacts with powerful new models of education and training that offer the potential to produce knowledge-based economies and the democratization of knowledge production.

The invention of computer networks in the late 1960s and computer-mediated communication (CMC) in the early 1970s initiated a shift in how we understand our most basic concepts of education, community and society. Our sense of who we are as citizens in the world, how we meet and collaborate with others, and how we learn and contribute to social development was transformed by the telecommunications revolution of the mid-19th century (telegraph, 1861; telephone, 1876) and early 20th century (television, 1925; satellite technology, 1957) and more recently and profoundly by the internet revolution in the mid-20th century. The developments associated with the internet and other online technological inventions have introduced profound implications for learning theory and practice.

A look at how quickly and widely computers and the internet have impacted on work and society worldwide is astounding: Arpanet was invented as recently as 1969, email over packet-switched networks was invented in 1971, computer conferencing/forums were invented in 1972, the public internet was launched in 1989, and the World Wide Web was invented in 1990 and released to the public in 1993.

It is important to recall that until the 19th century, communication was almost entirely restricted to one's locality. The first public transatlantic telegraph was sent by Queen Victoria in 1857. Until then, technologies for communicating at a distance were more or less similar to those of 5,000 years earlier: that is, messages were carried by bird, or by human courier on foot, using beast or boat. Distance communication was controlled by those with power (royal, military or religious leaders). Throughout history, communication among common people was limited to local, face-to-face conversation or the use of "distance" technologies—talking drums, smoke signals, carrier pigeons and semaphore (generally, though, these modes of communication were only employed in times of distress). Otherwise information traveled slowly. Even with the introduction of the printing press, important new ideas took years to disseminate from city to city, country to country or between Europe and the New World of the Americas. Until relatively recently, the spread of knowledge was limited.

In the 20th century the invention and adoption of the internet introduced a great leap forward in communication, both quantitatively and qualitatively. The internet represents a worldwide knowledge transformation on a global scale.

The invention of computer networking technologies has its roots in a vision of concern for collaboration, community, learning and knowledge. One of the earliest technological precursors is hypertext, a concept and technology important as the precursor and inspiration for the internet.

The history of hypertext began in 1945 with Vannevar Bush's article in the *Atlantic Monthly* entitled "As We May Think," about a futuristic technology that he called Memex, "a device in which an individual stores all his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility. It is an enlarged intimate supplement to his memory" (p. 108).

Bush's groundbreaking vision of a technology to enhance thought pre-dated the computer. Nonetheless, Bush's article and his concept of the Memex directly influenced and inspired the two Americans generally credited with the invention of hypertext—Ted Nelson and Douglas Engelbart.

Nelson coined the words "hypertext" and "hypermedia" in 1965 and worked to develop a computer system that enabled writing and reading that was nonsequential and presented the potential for cross-referencing and annotating (Nelson, 1974). In Project Xanadu, Nelson sought to create a computer networking system that enabled users to view hypertext libraries, create and manipulate text and graphics, send and receive messages and structure information. Such a system allowed users to create linkages among ideas and information resources, to explore the interconnections and generate multiple perspectives on a topic (Nelson, 1987). This vision pre-dates but anticipates the internet.

As with Vannevar Bush two decades earlier, Douglas Engelbart was concerned with enhancing people's intellectual capacity. In 1962, Engelbart published his seminal work, *Augmenting Human Intellect: A Conceptual Framework*, proposing to use computers to augment training. With his colleagues at the Stanford Research Institute, Engelbart developed a computer system to augment human abilities, including learning. The system, simply called the oNLine System (NLS), debuted in 1968 and later marketed as "Augment." One of the most notable design features of Augment is the emphasis on providing tools to support collaborative knowledge work. The Augment project "placed the greatest emphasis on collaboration among people doing their work in an asynchronous, geographically distributed manner" (Engelbart & Lehtman, 1988, p. 245). Augment enabled idea structuring, as well as idea sharing. While linkages among ideas and authors are supported by Augment, the system employs a hierarchical structure. Xanadu and Augment "were the first systems to articulate the potential of computers to create cognitive and social connectivity: webs of connected information and communication among knowledge workers" (Harasim, 1990a, p. 41).

The initial concept of a global information network came from J. C. R. Licklider in the late 1950s. At a time when computers were viewed as giant calculators, Licklider envisioned the use of networked computers to facilitate an online community, online personal communication and active, informed participation in government (Hafner & Lyon, 1996, p. 34). Licklider's 1950s visions were prescient and one of the earliest precursors to the rise of personal computers and computer networking.

In 1960, Licklider published his seminal paper "Man–Computer Symbiosis" in which he proposed the potential of computers to transform society. He put forward a vision that anticipated collaborative learning, emphasizing the potential of the computer to support group discussion, networking, multiple perspectives, active participation and community practice. Although Licklider left the Arpanet project before it was completed, his vision of Arpanet as a knowledge network remained. The actual technological development of Arpanet was the work of Lawrence G. Roberts of the Massachusetts Institute of Technology (MIT).

Another very important technological development related to human communication and collaboration was computer conferencing. Computer conferencing was invented to support group communication and decision-making, and the first system, EMISARI, was developed by Murray Turoff in 1971. In 1974 Turoff founded the Computerized Conferencing and Communications Center at the New Jersey Institute of Technology (NJIT) and developed the EIES computer conferencing system. Other conferencing systems developed in the early to mid-1970s were PLANET, Confer and *Forum. Computer conferencing is important to the history of online education because many of the earliest ventures in online course delivery involved computer conferencing. Over the next 35 years and to the present, Turoff engaged in research and development on CMC with Starr Roxanne Hiltz. Much of their work was and remains directly related to education and one of the most important outcomes was the development and implementation of the "Virtual Classroom," which pioneered the first total delivery of undergraduate education in the world. It was also the first major scientific field trial of online education and, as such, provided an important empirical base for others in the field (Hiltz,1994).

In 1990, Tim Berners-Lee, a British scientist at CERN (European Organization for Nuclear Research), invented the World Wide Web to meet the demand for information sharing among scientists working in different universities and institutes around the world. In 1992, Lynx was developed as an early internet web browser. Its ability to provide hypertext links within documents that could reach into other documents anywhere on the internet is responsible for the creation of the World Wide Web, which was released to the public in 1993.

Arpanet and Internet: Meeting of Minds

The origins of the first computer network, Arpanet, are linked to a vision of human collaboration and community. While the term *meeting of minds* was not actually used, this concept suggests a powerful metaphor to help understand computer networking. At one level, "meeting of the minds" (also referred to as mutual assent or *consensus ad idem*) is a phrase in contract law used to describe the intentions of the parties forming the contract. In particular, it refers to the situation where there is a common understanding in the formation of the contract, and Arpanet was essentially that, a mutual agreement to build a network but as networks had not yet been invented, it was a commitment to an intention.

Moreover, computer networks would represent a meeting of minds in both the social and technological aspects. The inventors of Arpanet employed social terms to characterize new tools and technologies. The basic formulation of Arpanet was based on cooperation and negotiation: the network host-to-host communications became facilitated by a "handshake," using the social term to describe a key technical concept of how the most elemental connections between two computers are handled. The term "protocol" was adopted from the ancient Greek *protokollon*, the top of a papyrus scroll that contained the synopsis of the document, its authentication and date (Hafner

& Lyon, 1996, p. 144). Protocols also reflect the etiquette of diplomacy, consensus and collective agreement. Network protocols became the technical and social glue of connectivity. A network protocol refers to the address of a packet of information but, as one of the notable architects of the internet, Vint Cerf, noted, social protocol also refers to informal consensus: "The other definition of protocol is that it's a handwritten agreement between parties, typically worked out on the back of a lunch bag, which describes pretty accurately how most of the protocol designs were done" (quoted in Hafner & Lyon, 1996, p. 146).

Network technology was socially and technically constructed by an informal group, the Network Working Group (NWG), who worked together in a collaborative and consensual manner. New ideas were sent out to group members and sites as notes called "Request for Comments" (these RFCs were sent via regular post: email had not yet been invented). A spirit of community, openness and collaborative design was invoked. As Hafner and Lyon remark: "For years afterward (and to this day) RFCs have been the principal means of open expression in the computer networking community, the accepted ways of recommending, reviewing, and adopting new technical standards" (1996, p. 145).

Finally, Arpanet represented a meeting of minds not only in the technological design and social construction of computer networking, but also in its applications. Email, computer conferencing, forums, the internet, virtual communities, online collaborative learning and online collaborative work were products of computer networking and, each in their own way, articulations of a meeting of minds.

Email is the first and most successful social software that has ever been invented. According to Internet World Stats, the penetration of the internet and email by the end of 2015 was 46.4% of the world's population or 3.4 billion people, representing an 832.5% growth rate from 2000–2015.

The Web

The World Wide Web was invented by Tim Berners-Lee in 1990 as a group work environment to facilitate online collaboration among his fellow scientists at CERN. Based on the concept of hypertext, the project was aimed at facilitating information sharing among researchers. The World Wide Web was originally conceived and developed to meet the demand for information sharing between scientists working in different universities and institutes all over the world. CERN is an organization, but it is not a single laboratory; rather, CERN is a focus organization for an extensive community that includes over 8,000 scientists and 60 countries. Although these scientists typically spend time on the CERN site, they usually work at universities and national laboratories in their home countries. Access to online communication was therefore essential to create and maintain the place-independent community.

The basic idea of the World Wide Web was to merge the technologies of personal computers, computer networking and hypertext into a powerful and easy-to-use global information system. Berners-Lee developed the protocols underpinning the World Wide Web in 1990. The first website went online in 1991. On April 30, 1993, CERN announced that the World Wide Web would be free to the public, to enhance interdisciplinary, international and inter-institutional discourse.

The rate of public adoption of the internet has been astronomical and the implications transformational. Within a few months of its public appearance, the World Wide Web was adopted worldwide as a means of facilitating ease of access to the internet and enabling vaster graphic capabilities. Within 15 years, the internet accumulated one billion users. By 2011, it had 2.2 billion users. The World Wide Web thus became central to public access to the internet and also enabled the creation of a global knowledge network.

The rise of the World Wide Web was a major catalyst in public use of online technologies: it made access to the internet easy; it also made the production of online graphics accessible to basic users, making the internet a hospitable and valuable communication space. The World Wide Web helped to popularize the term "online." "Online" was no longer a remote or obscure territory: even the next-door neighbors were "online." Communication activities such as email, forums and texting came to expand or replace postal mail, telephone calls and memos.

Having an email identity and online presence is today not only common but expected. An online presence is both a social and an economic phenomenon. We use it increasingly for social communication and work activities. In the early 21st century, the internet underwent a technological maturation and a shift that emphasized social interaction and new interactive tools. Whereas the original World Wide Web was based on static web pages, Web 2.0 focused on dynamic sharable content.

Web 2.0

Web 2.0 has come to be associated with, even defined as, the social or the collaborative web. While social communication, interaction and collaboration, as well as user-generated content, characterized learning networks, online education and virtual communities in the pre-web decades of Arpanet and the internet, the emphasis of Web 2.0 was on new or better tools for social interaction, community and collaboration and content construction. Web 2.0 marks an evolution in the tools available to create and support online communities, as well as new developments such as social networking sites, wikis, blogs and communities based on the sharing of social objects such as photos, videos, music, products, encyclopedia topics and classified ads.

Social Networks

The original social software of email and group forums remain major activities on the internet, but it is the invention and adoption of social networks that marks the keystone for Web 2.0. Online social networks, renowned for social discourse and relationship building, were first launched in 2004 with MySpace and Friendster. They have become the major online application. By the end of 2015, Facebook had 1.59 billion active monthly accounts with 1 billion daily users, and there are now at least 20 *major* social networking sites (excluding dating sites) which each have more than 100 million active users.

Figure 2.3 Web 2.0: The Collaboration Web.

Blogs

The term "blog" derives from weblog, which refers to a personal journal or diary that is available on the internet. The person who maintains and updates the blog is called a blogger. The term originated as a website devoted to a chronological publication of personal thoughts with associated web links, with the postings organized according to the most recent entry. Blog technology enabled the organization of text postings, images and hypertextual linkages. Blogs gained popularity during the 2004 US elections when they were used to report on or discuss political events. Blogs are written in a conversational manner, and a blog today will include comments from readers of the blog that can give rise to a discussion. Nonetheless, a blog is not intended to be a group discussion forum. Blogs were not developed to support social discourse and do not provide technological support for group discussions that evolve and deepen over time, unlike threaded discussion forums or computer conferences.

Social Objects

Web 2.0 is characterized by social networks that are built around the sharing and discussion of particular social objects. Social networks such as Facebook are built principally around the posting of messages, while other social networks have emerged based on the sharing of photos, videos or other products or media. Many of these networks are associated with the concept of user-generated content because the members create and post content that is public and can be shared with anyone on the internet.

Examples of social networks that have formed around social objects include:

- Twitter: allows communication through the exchange of short, quick and frequent messaging;
- WhatsApp: an app for iPhones and smartphones that allows for free messaging and sharing of photos and videos;
- Flickr: group discussion related to posting and sharing of photos;
- Amazon: group discussion related to posting and sharing of products;
- YouTube: group discussion related to posting and sharing of videos;
- Wikipedia: group discussion related to posting and sharing of encyclopedia topics.

Search Engines

A search engine is a computer program that searches and retrieves files or information from a computer database or computer network. An internet search engine is a computer program or tool to search the entire internet. Due to the vast quantity of information available on the internet, search engines have become an essential feature and tool for "surfing." Google.com, for example, is not only the leading search engine, but the most visited website in the world. It was registered on September 15, 1997, and by 2015 the site was receiving over 3.5 billion hits per day. The field of search engines is urgent given the exponential growth of the internet and its content. New search engines are being developed with new ways to search for, analyze and visualize information. While Google remains the leader in terms of market share, new developments such as visualization, the semantic web and cloud computing continually advance our ability to store and retrieve information and organize it for building knowledge. The capacity and scope of internet-based applications has grown exponentially.

The internet has also introduced remarkable opportunities for transforming teaching and learning and advancing online learning. However, the history of online learning began long before the World Wide Web; it was one of the earliest applications of the online network. Within a few years of the invention of Arpanet, the beginnings of online education took shape.

Historical Overview of Online Learning

Online learning (or online education) refers to the use of online communication networks for educational applications such as: course delivery and support of educational projects, research, access to resources and group collaboration. Online learning is mediated by the internet. The implications of the internet and its technologies for education are still unfolding—providing new experiences to generate understanding of how to benefit from and improve learning online. The need to understand how this major technological revolution is influencing education and transforming our discipline is critical, from the smallest to the most dramatic changes.

The earliest form of online education was invented in the mid-1970s by academics who were also engaged as Arpanet researchers. They were working on Arpanet developments, and presented the innovations they were encountering as topics in their university courses, thereby introducing students to email (then known as electronic mail) and computer conferencing as course content. Educational experimentation and student interest in these new communication technologies ignited exploration and, as a result, CMC became not only course content but pedagogical process. Students began to use email to send questions to their professors and comments to one another, while faculty explored applications of email and computer conferencing for providing additional information to students, clarifying questions and expanding opportunities for time- and place-independent group discussion in their courses.

Soon educators from a wider set of disciplines within universities—and eventually from the school system—began to experiment with educational CMC, and the "adjunct" or enhanced mode of online learning was born.

Adjunct Mode Online Learning

The adjunct or blended mode of online education refers to the use of network communication to enhance traditional face-to-face (or f2f) or distance education. In adjunct mode, the use of

TABLE 2.1 Brief History of Online Learning

Year	*Technology*	*Online Educational Applications*
1830s	Telegraph is invented	
1876	Telephone is invented	
1969	Arpanet is invented	
1971	Email is invented	
1972	Computer conferencing is invented	
Mid-1970s		First adjunct mode online courses
Mid-1970s		Online communities of practice (OCoP)
1981		First totally online courses (adult education)
1982		First online program (executive education)
1983		Blended classroom model emerges (schools)
1984		First totally online undergraduate courses
1985		First totally online graduate courses
1989	Internet launched	
1989		First large-scale online courses
1993	World Wide Web is made public	
1995		First state university adoption
1996		First large-scale online education field trials
1997		First industry-wide adoption
2004		Online education mainstreams and rise of social networking through creation of Facebook, starting a social networking revolution.

the internet is an add-on that complements the existing curriculum. The online activities do not replace the traditional techniques nor do they represent a significant portion of the course grade. They are used to enhance the class activities. Examples of this pedagogical approach include the use of email to contact a professor or submit assignments, the distribution of course material by the instructor, as well as the administering of quizzes or distribution of course grades. Adjunct mode also involves student use of the internet to search for course resources and undertake course-related research. It provides a new approach for extending group discussion: the use of computer conferences or forums enables the continuation of discussion initiated in class or the inclusion of guest experts or peers from other locations. Originating in the 1970s, adjunct mode was the first major educational application on the internet. Today, adjunct mode is ubiquitous in the use of the internet for learning throughout the world.

Mixed-mode or Blended-mode Learning

By the early 1980s, new online educational applications emerged, expanding adjunct mode into "mixed mode" or "blended mode," in which a significant portion of the traditional face-to-face classroom or distance education course was conducted online (Harasim, 2006a). Typically, about 50% of course activities and of the overall grade is based on online activities in blended mode. Today the term blended mode is used in many different ways: it typically refers to a mix of face-to-face and online course activities. However, blended learning can also be used to describe a pedagogical mix of distance education or courseware applications with online collaborative activities such as group discussions, seminars, debates, research or group projects. Blending may also be institutional, as in the case of a degree program offered by two or more institutions, or instructional, to refer to a course with team teaching.

Totally Online Learning

The earliest totally online courses were developed and offered in the mid-1980s at post-secondary levels. The courses were based on online collaborativist learning approaches such as seminars and group discussion (Mason & Kaye, 1989; Harasim, 1990b; Harasim, Hiltz, Teles, & Turoff, 1995; Harasim, 2006a).

As educators and researchers adopted this new domain in their work, they also wrote about it and presented their experiences at scholarly and professional venues; interest in online learning was generated and the field began to grow. However, in its early manifestations in the 1980s, it remained limited to a relatively small group of early advocates.

Most of the early online learning pioneers came from the face-to-face classroom context. The earliest users and adopters emphasized pedagogies involving student collaboration, interaction and knowledge building. In the decade before the public launch of the internet and the World Wide Web, distance education did not identify with online education, nor were courseware providers able to easily offer their individualized multimedia pedagogy online. The collaborative learning approach was largely the norm for online education in the 1980s.

Summary

Chapter 2 discussed how from humankind's earliest days, learning and technology have been profoundly interconnected; they are kindred spirits, consonant and interconnected. And, linked to collaboration, they enhance the essence of what it means to be human. The four major paradigmatic shifts associated with speech, writing, printing and the internet illuminate how technology and learning formed the basis for civilizational advances. The invention of the internet is transforming our contemporary society, thereby introducing opportunities and motivation for changing the conditions of learning: how we view learning, and how we can shape our educational practice to better support learning.

Chapter 2 provided an introduction for Chapters 3, 4 and 5 which examine key learning theories and technologies in the 20th century. These chapters also build a framework for considering new theoretical approaches for teaching and learning online which will be examined in Chapter 6 and beyond.

3
Behaviorist Learning Theory

The science of education can and will itself contribute abundantly to psychology. Not only do the laws derived by psychology from simple, specially arranged experiments help us to interpret and control mental action under the conditions of schoolroom life. Schoolroom life itself is a vast laboratory in which are made thousands of experiments of utmost interest to "pure" psychology.

—Edward L. Thorndike, 1910

Chapter 3 presents the following topics:

- Context of behaviorist theory
- Behaviorist learning theory and major thinkers
  - Pavlov
  - Watson
  - Thorndike
  - Skinner
- Behaviorist learning pedagogy
  - Reward and punishment
  - Behavioral instructional design
  - Taxonomies of learning
- Behaviorist learning technology
  - Teaching machines
  - Computer-assisted instruction (CAI).

Context of Behaviorist Theory

The 20th century marks the period when theories of learning and academic scholarship in education emerged and flourished. Given the 1,000-year history of formalized learning, it may be surprising to discover that a science or theory of learning emerged only in the past 100 years. However, as Chapter 1 explained, while discussions of learning have been ongoing for millennia, these discussions were rooted in philosophy and religious thought, not theory.

Positivism and the rise of scientific method had a strong influence on the emerging field of education in the early 20th century. In particular, the discipline of psychology had an impact on education because psychology studied human behavior and had already established empirical research methods based on a positivist framework. In general, learning theories of the 20th century were derived from educational psychology. Educational researchers and psychologists sought to better understand learning by collecting and analyzing empirical data generated through clinical experimentation. The nature of learning, how learning occurs, what influences learning (positively and negatively), how to structure and support learning and what we believe learning to be were largely based on interpretations of experiments with laboratory animals. The resultant perspectives were influential, but also issues of significant debate.

In the early 20th century, with the rise of modern science and new communication technologies, the speed of change increased: ideas were more easily communicated, disseminated and debated. Freud, together with his colleagues, had contributed to the rise of psychology as an empirical field and discipline. Moreover, to some degree it was Freudian theory that influenced and led to the first theory of learning: behaviorism. Behaviorism emerged as a reaction *against* the Freudian emphasis on the unconscious mind and the Freudian use of introspective analysis and self-reports to study the mind. Behaviorism was a counterargument to this position. Behaviorism distrusted self-reports as a source of reliable data and instead emphasized that which was strictly observable. Under behaviorism, the definition of learning was reduced and simplified to simple conditioning: the stimulus and the response. The motto of behaviorism might well be expressed as "behavior, not mind!"

Behaviorist Learning Theory

Behaviorist learning theory focuses on that which is observable: how people behave and especially how to change or elicit particular behaviors. In the early 20th century, behaviorism introduced a theory of learning that was empirical, observable and measurable.

This earliest theory of learning emphasized overt action: that which was most easily apparent and accessible for study, behavior. The term "overt action" means behavior and behaviorists studied how we act and what impacts upon and changes how we act. Based on clinical experiments with animals, behaviorist thinkers discovered that a response to certain stimuli would be repeated and could be observed, controlled and quantified.

Behaviorist theory could not account for subjectivity and, given its historical context, it would not. The early rise of scientific theory was set in the context of positivism. To be considered a "science," behaviorism had to adhere to rigid positivist principles which were based upon rigorous "objectivity" and ignored or dismissed "subjectivity" and anything to do with introspection or mental states (called mentalism at the time). To be considered scientific, research must employ the experimental method, which involves manipulating one variable to determine if changes in one variable cause changes in another variable. This method relies on controlled methods, random assignment and the manipulation of variables to test a hypothesis.

> [B]ehaviorism embodies two of the key principles of positivism: that our knowledge of the world can only evolve from the observation of objective facts and phenomena; and that theory can only be built by applying this observation in experiments where only one or two

> factors are allowed to vary as a function of an experimenter's manipulation or control of other related factors. (Winn & Snyder, 1996, p. 114)

In behaviorist theory, what is in the mind is not accessible for study, and is hence irrelevant and should not be considered in research. The mind is viewed as a black box that is largely irrelevant and, therefore, by extension educational practice based on behaviorist terms would not take the mind into account. The emphasis is on environmental stimulus and observed response.

Behaviorist learning theory emphasizes two major types of conditioning:

- *classical conditioning*: for example, Pavlov's dog experiments in which behavior becomes a reflex response to a stimulus; and
- *operant conditioning*: the example of Skinner's rat experiments, which refer to the reinforcement of a behavior by a reward or punishment.

Pavlov: Classical Conditioning

The development of behaviorism is associated with many scientists, but most famously with the Russian physiologist, Ivan Pavlov (1849–1936), who is considered the intellectual founder of behaviorist learning theory. He is famous for his theory of classical conditioning and his experiments with a dog, food and a bell. Pavlov was a physiologist involved in medical research, with a special interest in reflexes. Reflexes are automatic behavior caused by stimulus in the environment: the smell of food cooking causes us to salivate. In 1904 Pavlov won the Nobel Prize in Medicine (Physiology) in recognition of his work on the physiology of digestion. It was his pioneering work on digestion that led him to serendipitously discover what he subsequently called conditioned reflexes. Pavlov was studying the physiology of digestion in dogs when he discovered that in addition to salivating in the presence of meat powder, dogs had begun to salivate in the presence of the lab technician who fed them, even if there was no meat powder around. The dogs had learned to associate food with the person who fed them; this person became the stimulus for the food and his presence would cause salivation on its own. Pavlov began to study the stimulus and response in dog salivation using a bell (a neutral stimulus), which became associated with feeding time, and thus became a conditioned stimulus as a result of consistent pairing with the unconditioned stimulus, meat powder in this example. Pavlov referred to a relationship that can be learned as conditional reflex, as opposed to unconditioned reflexes that are natural. This became the theory of classical conditioning. Pavlov manipulated the situation of stimulus–response, by linking a conditional stimulus (the bell) to the unconditional stimulus (the food), and eventually took the unconditional stimulus away. The dog now salivated to the bell. This demonstrated that behavior could be manipulated through conditioning: responses could be manipulated or learned. Pavlov proved that a conditional stimulus could cause a response on its own, demonstrating that classical conditioning succeeded. Classical conditioning refers to a theory about how behavior is learned and was first applied to animals and then to humans.

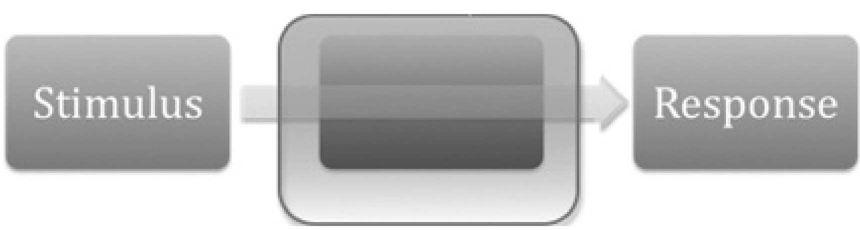


Figure 3.1 Behaviorist "Black Box."

Here is a simple description of Pavlov's experiment:

- Before conditioning: the dog is a normal canine; placing food in front of the dog stimulates the dog to salivate.
- During conditioning: a bell rings a few seconds before food is presented in front of the dog.
- After conditioning: the ringing bell is enough to cause the dog to salivate, even when food is absent.

The above experiment may seem simplistic but the results are widely regarded as representing the first major theory of learning; that is, a theory based on scientific evidence that is replicable and observable. Behaviorism emphasized that the repetition of a certain behavioral pattern makes that pattern automatic. If it is replicable and observable, then it is real. This is the underlying behaviorist theory of learning. Behaviorism was based upon empirical evidence and arguably, therefore, part of the emerging stream of scientific processes, reflecting modern science.

Watson

Many psychology researchers expressed interest in Pavlov's ideas, and as his research shifted to human behavior, these other researchers also contributed their ideas on human psychology and learning theory to build a school of thought. John B. Watson (1878–1958) was the first American psychologist to use Pavlov's ideas and is credited with coining the term "behaviorism." In 1913, Watson published *Psychology as the Behaviorist Views It*. "Psychology as the behaviorist views it," wrote Watson,

> is a purely objective experimental branch of natural science. Its theoretical goal is the prediction and control of behavior. Introspection forms no essential part of its methods, nor is the scientific value of its data dependent upon the readiness with which they lend themselves to interpretation in terms of consciousness. (1913, p. 158)

He subsequently wrote many other works on the subject. Watson was very firmly a behaviorist and a significant force in establishing behaviorism in the United States. He describes psychology

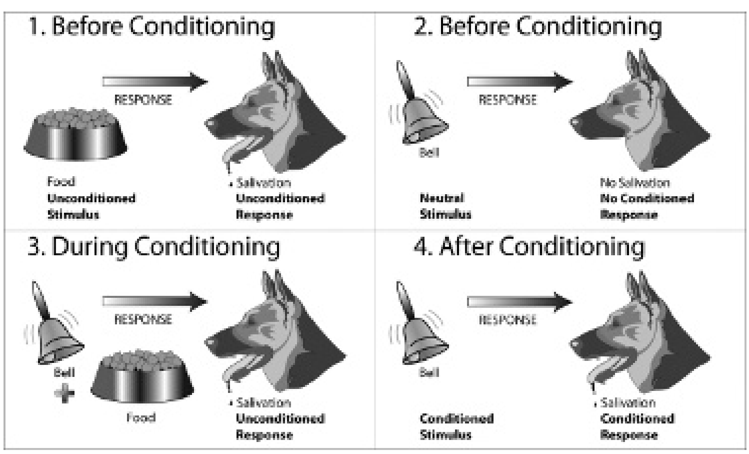


Figure 3.2 Classical Conditioning: Pavlov's Dog Experiment.

as the process where behavior is predictable and controlled, and he argues that terms such as *consciousness*, *mind* or *images* do not have a place in psychology:

> I believe we can write a psychology … and … never use the terms consciousness, mental states, mind, content, introspectively verifiable imagery, and the like. … It can be done in terms of stimulus and response, in terms of habit formation, habit integrations and the like. … In a system of psychology completely worked out, given the response the stimuli can be predicted; given the stimuli the response can be predicted. (1913, p. 167)

Thorndike

Edward L. Thorndike (1874–1949) was interested in the association or connection between sensation and impulse, and studied learning connected to action. His work is referred to as *connectionism* within the behaviorist school. Thorndike's experiments with a "puzzle box" measured the amount of time it took an animal to operate the latch of the box and to escape. The animal was repeatedly returned to the puzzle box and would again escape. The amount of time taken to escape decreased with exposure, however, as the animal associated the inside of the box with the impulse to escape. These experiments supported the view that learning is the result of associations forming between stimuli (S) and responses (R). According to Thorndike, such associations or "habits" become strengthened or weakened by the nature and frequency of the S–R pairings. Thorndike's S–R theory was based on the concept of trial-and-error learning in which certain responses come to dominate others due to rewards. Thorndike's experiments also led him to question the existence of the animal's mental states, suggesting that the animals act without thinking or feeling. Connectionism (like all behavioral theory) posited that learning could be adequately explained without referring to any unobservable internal states.

Skinner: Operant Conditioning

The American psychologist, Burrhus Frederic Skinner (1904–1990), is also famously associated with behaviorist learning theory. However, Skinner's work differed from his Pavlovian predecessors in that he focused on voluntary or operant behavioral conditioning, whereas Pavlov focused on what is known as classical conditioning.

Operant conditioning was introduced by Skinner as an alternative to Pavlov's classical conditioning. Pavlov's work focused on how a neutral stimulus, such as a bell, affected a result, whereas Skinner explored how a direct stimulus led to a positive response that created a behavioral change. Skinner's work is known as operant conditioning, and emphasizes the use of positive and negative reinforcement to manipulate or teach new behavior. Operant conditioning is related to voluntary behavior rather than involuntary reflexive responses.

Through experimentation Skinner discovered that behavior can be conditioned by using both positive and negative reinforcement. One well-known example is that of a laboratory rat learning to find the cheese in a maze. Positive reinforcement conditions the rat to find the end of the maze through successive approximations, or steps. First, the rat is placed in a maze with the cheese located nearby. The rat is rewarded with the cheese when it reaches the first turn (A). Once the first kind of behavior becomes ingrained, the rat is not rewarded until it makes the second turn (B). After many times through the maze, the rat must reach the end of the maze to receive its reward (C). Skinner's research on operant conditioning led him to conclude that simply rewarding small acts can condition complex forms of behavior.

Operant refers to the process of operating on the environment. The subject, in this case a rat, is doing whatever it does in the box shaped like a maze. While so doing (operating), the rat encounters a special stimulus, cheese. The cheese is called a reinforcing stimulus. This special stimulus has the effect of changing or modifying the behavior of the subject, tending to reinforce the tendency to repeat the behavior in future. The stimulus will cause the rat to make the correct turn in the maze to find the cheese. If the cheese is moved, the rat must learn to follow the pathway until another reward is discovered (by taking another turn in the maze), and so on. If the cheese disappears, the operant behavior is extinguished. A behavior followed by the reinforcing stimulus results in increased probability of that behavior occurring in the future, whereas a behavior no longer followed by the reinforcing stimulus results in a decreased probability of that behavior.

However, experiments also demonstrated that many repetitions were required before laboratory animals (mice, rats) learned that certain responses resulted in a reward of food (stimulus). Skinner found that such changes in behavior took considerable time and required many successive approximations of behavior. This meant that any changes in behavior required many repetitions before they were learned. Often a big change would be reduced to many smaller acts or components repeated over a long period.

Skinner was a strong adherent of behaviorism and focused on changes in observable behavior, ignoring the possibility of any processes in the mind. He dismissed mentalism or processes of the mind as "fiction." Skinner concentrated on science as empirical observation and viewed psychology as part of the scientific revolution (he excluded biology and the social sciences). Psychology need not consider fictional concepts such as "subjectivity," because psychology was a science.

> Psychology, alone among the biological and social sciences, passed through a revolution comparable in many respects to that which was taking place at the same time in physics. This was, of course, behaviorism. The first step, like that in physics, was a reexamination of the observational bases of certain important concepts. … Most of the early behaviorists, as well as those of us just coming along who claimed some systematic continuity, had begun to see that psychology did not require the redefinition of subjective concepts. The reinterpretation of an established set of fictions was not the way to secure the tools then needed for a scientific description of behavior. … There was no more reason to make a permanent place for "consciousness," "will," "feeling," and so on, than to make a permanent place for "phlogiston" or "vis anima." (Skinner, 1964, p. 292)

In 1948, Skinner published the book *Walden Two*, about a utopian society based on operant conditioning. *Walden Two* is a science fiction novel that presents an experimental community based on a planned economy, that is critical of inefficient capitalism. The community's government is not democratic and is governed by Planners and Managers. The code of conduct is based on

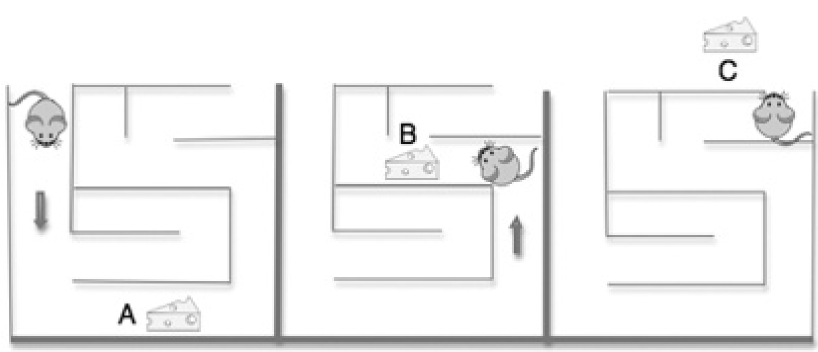


Figure 3.3 Operant Conditioning: Skinner's Rat and Cheese Maze.

behaviorism. Work is limited to 4 hours daily from each person and engaging in the arts and applied scientific research is promoted. Children are educated communally by trained behavior specialists, outside the nuclear family, who are loyal to the community.

Skinner's 1953 book, *Science and Human Behavior*, was a non-fiction consideration of how operant behavior could function in reality, in such social institutions as education, economics, law, religion and government. Operant conditioning would shape behavior through such mechanisms as positive reinforcement (reward), negative reinforcement, non-reinforcement and punishment.

However, there were some significant problems with Skinner's own science, in particular a disturbing disjuncture between his model and the empirical results of his experiments. Some researchers argued that his claims exceeded his evidence and that he could not prove or demonstrate empirically that the responses were the result of a particular stimulus. Skinner responded to these criticisms, the "psychologist's fallacy" attributed to the stimulus–response model, by creating a set of highly controlled conditions in which a discriminating stimulus could be defined and linked to a specific and particular response. But Skinner's approach to creating a positivistic and interpretation-free psychology resulted in a model that was testable only under very limited and limiting conditions. And this too was critiqued. Skinner's work on verbal behavior was criticized, for example, by Noam Chomsky (1959), who argued that Skinner's claims exceeded what was "lawfully" demonstrated by his research, and wrote that Skinner either had to reduce his claims or admit that they were not based on scientific evidence. Most behavior could not be explained by Skinner's research, wrote Chomsky:

> If he (a behaviorist) accepts the broad definitions, characterizing any physical event impinging on the organism as a stimulus and any part of the organism's behavior as a response, he must conclude that most behavior has not been demonstrated to be lawful. … If we accept the narrower definitions, then behavior is lawful by definition (if it consists of responses); but this fact is of limited significance, since most of what the animal does will simply not be considered behavior. Hence the psychologist either must admit that behavior is not lawful, or must restrict his attention to those highly limited arenas in which it is lawful. … Skinner does not consistently adopt either course. (1959, p. 30)

Eric Bredo's (2006) article "Conceptual Confusion and Educational Psychology" addressed issues where learning theorists demonstrated psychological fallacies and limitations in their positions. Bredo writes of behaviorism:

> In effect, the doctrinaire behaviorist has to choose between being "scientific" in a narrow positivistic sense only under highly controlled conditions, or generalizing to less controlled conditions in a merely metaphorical or interpretive way. Chomsky argued that Skinner could not have it both ways. (2006, p. 49)

Moreover, Bredo suggests the stimulus–response model of the organism tends toward notions of mechanization of education and management of learning, in which a "real science" of psychology would be based on what was essentially an "input–output model of the organism. It also seemed as though a positivistic psychology might make it possible to mechanize education and perhaps even create a scientifically managed social utopia" (Bredo, 2006, pp. 47–48). The S–R model was criticized as narrow, conceptually confused and mechanistic.

As early as 1896, John Dewey had already criticized the stimulus–response model as deterministic and wrong because it succumbed to the psychologist's fallacy. He wrote:

> The fallacy that arises when this is done is virtually the psychological or historical fallacy. A set of considerations which hold good only because of a completed process, is read into the content of the process which conditions this completed result. A state of things characterizing an outcome is regarded as a true description of the event which led up to this outcome; when as a matter of fact, if this outcome had already been in existence, there would have been no necessity for the process. (1896, p. 367)

Behaviorist learning theory has been most successful or relevant in contexts where the learning objectives to be attained are unambiguous and where their attainment can be judged according to commonly agreed upon criteria of successful performance in task-oriented learning. Examples might be learning accountancy procedures, learning to swim or learning to operate a sophisticated machine.

Behaviorist Learning Pedagogy

Behaviorist pedagogy aims to promote and modify observable behavior in people. Learning is considered a behavior that demonstrates acquisition of knowledge or skills. To understand behaviorist learning pedagogy, we look at the following three techniques and models:

- reward and punishment;
- behavioral instructional design;
- taxonomies of learning.

Reward and Punishment

Behaviorist techniques are employed in education to promote behavior that is desirable and to discourage that which is not. The most common is the behaviorist technique of reward (positive reinforcement) and punishment (negative reinforcement). A number of classroom practices find their roots in this technique. Some examples are outlined below.

- *Contracts* are established between a student and a teacher or a counselor regarding behavior change. If a student is not completing homework, the student and teacher might design a contract outlining agreed upon changes: for example, the student agrees to request extra help and the teacher agrees to be available after school to provide additional assistance.
- *Consequences* occur immediately after a behavior, and may be positive or negative, short or long term. Consequences occur after the "target" behavior occurs and, whether positive or negative, reinforcement may be applied.
- *Positive reinforcement* (reward) is the presentation of a stimulus that increases the likelihood of a response. For example, a teacher provides positive reinforcement by smiling at students after they provide a correct response or commending students for their good work.
- *Negative reinforcement* increases the likelihood of a positive behavior by withdrawing or removing a consequence that the student finds unpleasant. For example, achieving an 80% score on a test makes the final exam optional.
- *Positive punishment* refers to adding something that decreases the undesired behavior. For example, after-school detention for coming to school late.
- *Negative punishment* refers to removing something that decreases the undesired behavior. An example is missing recess as a consequence of misbehaving in class. (Standridge, 2002)

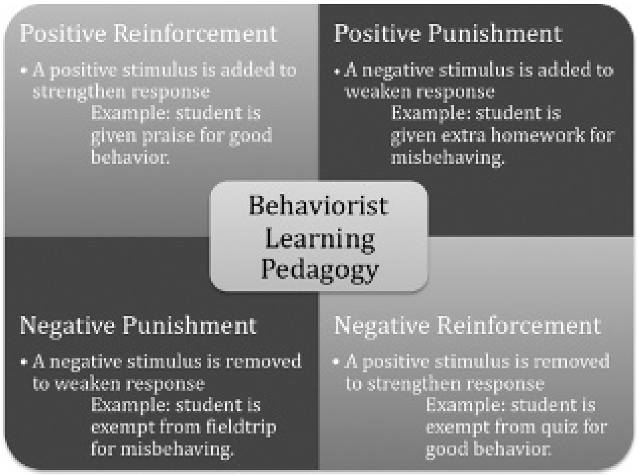


Figure 3.4 Examples of Behaviorist Pedagogy: Punishment and Reinforcement.

The prevailing pedagogy of behaviorist learning theory is aimed at achieving the correct (intended) behavior. Behaviorist learning theory focuses significantly on predictability: that is, ensuring that what is intended is achieved, and that the link between a stimulus and the response it evokes is reliable. The response to a particular stimulus should be consistent, automatic and replicable, time after time.

A correct response to a stimulus would receive a positive reward. An incorrect response to a stimulus would yield a negative response (punishment). Behavioral pedagogies were rigidly adopted in some quarters within the field of learning theory. Memorization, repetition, reinforcement of correct answers, examinations and the organization of the curriculum content into specific behavioral objectives were the result.

Behavioral Instructional Design

Behaviorism was prominent in the origins of instructional design. Instructional design is the systematic planning and presenting of instructional sequences, based on a theory of learning. Behavioral instructional theory therefore consists of prescriptions for what stimuli to employ if a particular response is intended. "The instructional designer can be reasonably certain that with the right set of instructional stimuli all manner of learning outcomes can be attained" (Winn & Snyder, 1996, p. 133).

As Watson (1919) argued, the focus of instructional design is precision, prediction and replication:

> We want to predict with reasonable certainty what people will do in specific situations. Given a stimulus, defined as an object of inner or outer experience, what response may be expected? A stimulus could be a blow to the knee or an architect's education; a response could be a knee jerk or the building of a bridge. Similarly, we want to know, given a response, what situation produced it. … In all such situations the discovery of the stimuli that call out one or another behavior should allow us to influence the occurrence of behaviors: prediction, which comes from such discoveries, allows control. (quoted in Burton, Moore, & Magliaro, 1996, p. 47)

Behavioral instructional design was also influenced by its context. In addition to the emphasis on predictable change in student behavior, behavioral instructional design was also influenced by

World War II military trainers (and psychologists) who emphasized practice and reinforcement in military training. They determined the learning outcomes necessary for "performance" and identified the specific "tasks" required to perform a job. "Based on training in the military during the Second World War, a commitment to achieve practice and reinforcement became major components to the behaviorist-developed instructional design model (as well as nonbehavioristic models)" (Burton et al., 1996, p. 58). This definition of education and learning as control and predictability of behavior became increasingly controversial: while Bertrand Russell claimed that Watson made "the greatest contribution to scientific psychology since Aristotle," others referred to Watson as the "simpleton or archfiend … who denied the very existence of mind and consciousness [and] reduced us to the status of robots" (Malone, 1990, as quoted by Burton et al., 1996, p. 47).

Taxonomies of Learning

Behaviorism emphasized the ability to analyze and deconstruct the elements or steps of learning into instructional design, by breaking down a task into smaller steps or chunks and by specifying behavioral objectives. To develop behavioral objectives, it is necessary to identify and specify quantifiable behaviors or outcomes: for example, *95% of learners will correctly answer all questions on this post-test, after completing the assigned educational unit.* Learning success was assessed by tests developed to measure performance in relation to each objective.

Taxonomies or classifications of learning behaviors were therefore considered to be important, in order to design and test instruction. Benjamin Bloom's 1956 taxonomy of learning (cognitive, affective and psychomotor domains) is a classic in this field. Benjamin Bloom (1913–1999) was an American educational psychologist recognized for his significant contribution to the classification of educational objectives. He worked on the problem of how to develop specifications so that educational objectives could be organized according to their cognitive complexity. Such a classification or hierarchy would be the basis for assessing student outcomes and provide professors with more reliable procedures for setting and assessing instructional objectives. It could also serve as a means for formulating instructional objectives.

Developed, in fact, by a committee of college and university examiners, Bloom was the editor and principal author of *Taxonomy of Educational Objectives: The Classification of Educational Goals.* The purpose of a taxonomy, as Bloom noted in his Foreword, was to permit classification of educational objectives just as biological taxonomies classified plants and animals into such categories as phylum, class, order, family and genus. Bloom "intended to provide for classification of the goals of our educational system. It is expected to be of general help to all teachers, administrators, professional specialists, and research workers who deal with curricular and evaluation problems" (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956, p. 1). The taxonomy could help teachers specify curricular objectives and ensure that educational plans covered the range of behaviors required to be taught.

The taxonomy was to comprise three handbooks. Handbook I addressed the cognitive domain and was published in 1956. It is the text commonly referred to as Bloom's taxonomy of learning. Handbook II, on the affective domain, and Handbook III, on the manipulative or motor-skill area, were produced by other writers. Handbook I focused on the cognitive domain, which involves knowledge and development of intellectual skills including recall or recognition of specific facts, procedural patterns and concepts that serve in the development of intellectual abilities and skills. The six categories set out as learning objectives for students were listed according to level of difficulty, in that the first must be mastered before the next. Bloom describes these as follows:

a. *Knowledge*:

> Knowledge, as defined here, involves the recall of specifics and universals, the recall of methods and processes or the recall of a pattern, structure or setting. For measurement purposes, the recall situation involves little more than bringing to mind the appropriate materials. Although some alteration of the material may be required, this is a relatively minor part of the task. The knowledge objectives emphasize most the psychological processes of remembering. (Bloom et al., 1956, p. 201)

Knowledge is further structured into subcategories:

- knowledge of specifics;
- knowledge of ways and means;
- knowledge of the universals and abstractions in a field;
- *sample behavior: the student will recall the three subcategories of Bloom's definition of knowledge.*

b. *Comprehension*:

> This represents the lowest level of understanding. It refers to a type of understanding or apprehension such that the individual knows what is being communicated and can make use of the materials or idea being communicated without necessarily relating it to other materials or seeing its fullest implications. (Bloom et al., 1956, p. 204)

Subcategories include:

- translation;
- interpretation;
- extrapolation;
- *sample behavior: the student will explain the purpose of Bloom's taxonomy of the cognitive domain.*

c. *Application*:

> The use of abstractions in particular and concrete situations. The abstractions may be in a form of general ideas, rules of procedures or generalized methods. The abstractions may also be technical principles, ideas and theories which must be remembered and applied. (Bloom et al., 1956, p. 205)

- *Sample behavior: the student will write an instructional objective for each level of Bloom's taxonomy of the cognitive domain.*

d. *Analysis*:

> The breakdown of a communication into its constituent elements or parts such that the relative hierarchy of ideas is made clear and/or the relations between ideas expressed are made explicit. Such analyses are intended to clarify the communication, to indicate how the communication is organized and the way in which it manages to convey its effects, as well as its basis and arrangement. (Bloom et al., 1956, p. 205)

Analysis is divided into:

- analysis of elements;

- analysis of relationships;
- analysis of organizational principles;
- *sample behavior: the student will compare and contrast the cognitive and affective domains.*

e. *Synthesis*:

> The putting together of elements and parts so as to form a whole. This involves the process of working with pieces, parts, elements, etc., and arranging and combining them in such a way as to constitute a pattern or structure not clearly there before. (Bloom et al., 1956, pp. 205–206)

Subsections are:
- production of a unique communication;
- production of a plan, or proposed set of operations;
- derivation of a set of abstract relationships;
- *sample behavior: the student will design a classification scheme for writing educational objectives that combines the cognitive, affective and psychomotor domains.*

f. *Evaluation*:

> Judgments about the value of materials and methods for given purposes. Quantitative and qualitative judgments about the extent to which material and methods satisfy criteria. The criteria may be those determined by the student or those which are given to him. (Bloom et al., 1956, p. 207)

- judgments in terms of internal evidence;
- judgments in terms of external criteria;
- *sample behavior: the student will judge the effectiveness of writing objectives using Bloom's taxonomy of the cognitive domain.*

Learning taxonomies assisted instructional designers in identifying behaviors that could be deconstructed and programmed as learning objectives and tasks, as well as in quantifying and assessing the outcomes. Learning taxonomies provided a kind of framework or template for describing and categorizing human behavior, although trying to identify the immense range of all human behaviors soon proved to be unrealistic and impossible. In 1962, Robert Gagné developed a taxonomy of learning that comprised five domains. Gagné's taxonomy became the basis for cognitivist instructional design and technology and is discussed in greater detail in Chapter 4.

Behaviorist Learning Technology

Instructional technology has its roots in behaviorism. The rise of scientific methodology and the study of how people learn coincided with mechanization in the labor force and demands for an increasingly educated population.

Industrialization required workers who could read and follow instructions. They should be able to perform their tasks repeatedly and reliably. Education must be able to teach literacy and to instill the discipline for repetitious behavior and predictable performance at work. Mass schooling and compulsory education were developed to meet these needs. These needs were also fueled by World War II and the need for highly skilled workers, which required major training initiatives.

Behavioral learning theory lent itself not only to instructional design based on very specific and discrete learning steps, but also to mechanization of this process through new forms of learning technologies. Learning technologies that were intended to encourage practice and reinforcement of specific tasks were developed. Mechanization also appealed to the need for efficiency and to making instruction more methodical. Two major examples of technologies based on behaviorist learning theory emerged:

- teaching machines and programmed instruction;
- computer-assisted instruction (CAI).

Teaching Machines and Programmed Instruction

Teaching machines were first developed in the mid-1920s as self-scoring testing devices. The teaching machine housed a list of questions and a mechanism through which the learner responded to questions. Upon delivering a correct answer, the learner was rewarded. The earliest examples of teaching machines included automatic (chemically treated) scoring cards used for self-checking by students while studying the reading assignment. A similar form of individualized learning and immediate feedback was achieved with the use of punch cards.

Another early example is the testing device developed by Sidney Pressey, an educational psychology professor at Ohio State University. He developed a machine to provide drill-and-practice items to students in his introductory courses. Pressey (1926, p. 374) stated, "the procedures in mastery of drill and informational material were in many instances simple and definite enough to permit handling of much routine teaching by mechanical means." The teaching machine that Pressey developed, shown in Figure 3.5, resembled a typewriter carriage with a window that

Figure 3.5 Pressey's Testing Machine.

revealed a question with four possible answers. On one side of the carriage were four keys. The user pressed the key that corresponded to the correct answer. When the user pressed a key, the machine recorded the answer on a counter at the back of the machine and revealed the next question. After the user had finished, the person scoring the test slipped the test sheet back into the device and noted the score on the counter.

Skinner updated the teaching machine in the 1950s, shown in Figure 3.6, under the name of programmed instruction (PI). PI derived from teaching machines by linking self-instruction of the content with self-testing. This approach dominated the field in the 1960s and 1970s. Whereas earlier forms of teaching/testing devices employed multiple-choice approaches, Skinner required students to form composed responses (words, terms) and he sought totally correct answers; PI would reinforce a response that was close to the correct answer/behavior and through successive approximations would seek to achieve the desired behavior and avoid any wrong answers.

PI was based on Skinner's theory of "verbal behavior" as a means to accelerate and increase conventional educational learning. It consisted of self-teaching with the aid of a specialized textbook or teaching machine that presented material structured in a logical and empirically developed sequence or set of sequences. PI allowed students to progress through a unit of study at their own rate, checking their answers and advancing only after answering correctly. In one simplified form of PI, after each step, students are presented with a question to test their comprehension, then immediately shown the correct answer or given additional information. The main objective of instructional programming is to present the material in small increments so that students can approximate and eventually achieve total accuracy in their responses.

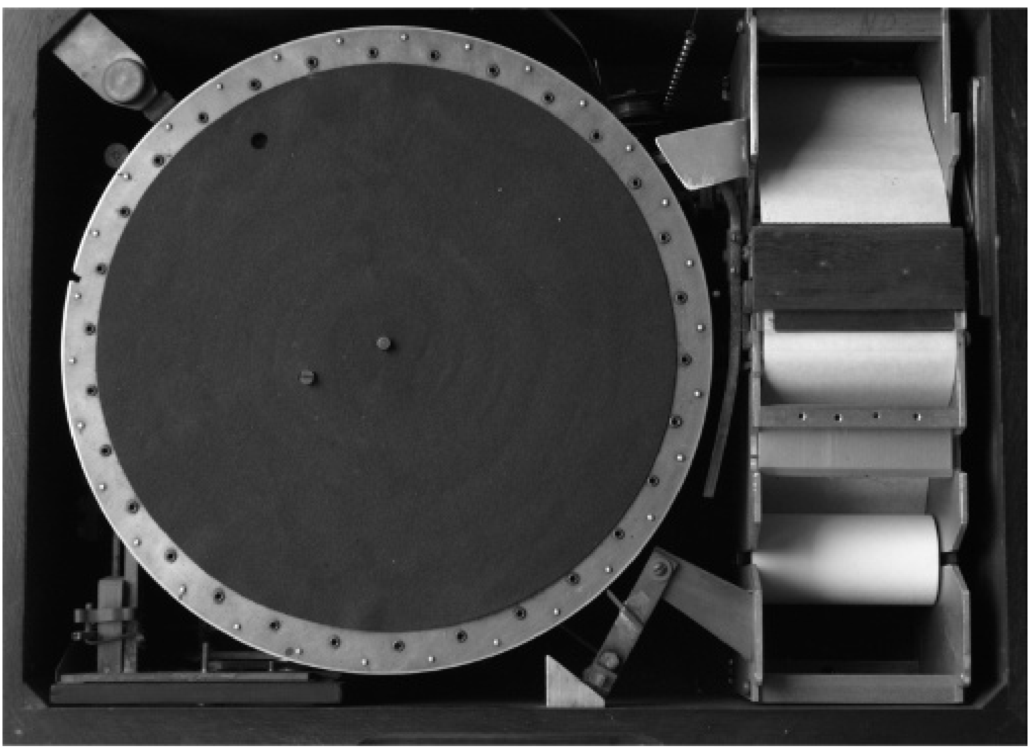


Figure 3.6 Skinner's Teaching Machine.

Teaching machines and PI emphasized the development of hardware rather than software (or content). Even though PI eventually came to focus more on content and analysis of instruction, it soon disappeared from educational consideration and use.

Computer-Assisted Instruction (CAI)

Computer-assisted instruction (CAI) was developed during the 1950s for teaching and training. CAI is essentially a drill-and-practice approach to learning, and control is with the program designer and not the learner (although small levels of individual customization were implemented). It is the earliest example of educational applications of a computer. Computing in the 1950s and 1960s was very complex but educational applications were already being envisioned and implemented. Due to significant technical problems, lack of quality software and high costs, this approach did not initially flourish. However, the US Department of Defense became a major, and occasionally the major, player in funding CAI developments during the 1950s and until today (Fletcher, 2009). Two early projects were PLATO and TICCIT. PLATO (Programmed Logic for Automated Teaching Operations) was specifically designed for developing and presenting instruction. PLATO was one of several projects at the University of Illinois Coordinated Science Laboratory funded by the military in the 1950s. Its major impact is considered to be in "encouraging individuals to develop and use CAI" (Fletcher, 2009, p. 72). TICCIT (Time-shared Interactive Computer-controlled Television) was developed at the University of Texas, and later Brigham Young University, as a computer system designed to implement the formal principles of instructional design. Many of the techniques developed for PLATO and TICCIT found their way into K–12 (Kindergarten to grade 12 or secondary education) and university education.

In the 1980s, with the rise of personal computing and its appearance in the school system, CAI approaches flourished in the public sector. There were as yet no competing educational computing options. Personal computers were in their initial stages, and educational adoption of computers was at its most primitive. Drill-and-practice and "electronic page turning," both associated with CAI, were the earliest forms of educational software. These approaches were relatively easy to program on a computer; they required little computer memory and reflected the low level of understanding of educational computing at the time.

The military, however, found CAI approaches to be highly efficient. While the costs of anticipating responses to all learner states and interactions were a problem, a growing body of data indicated success.

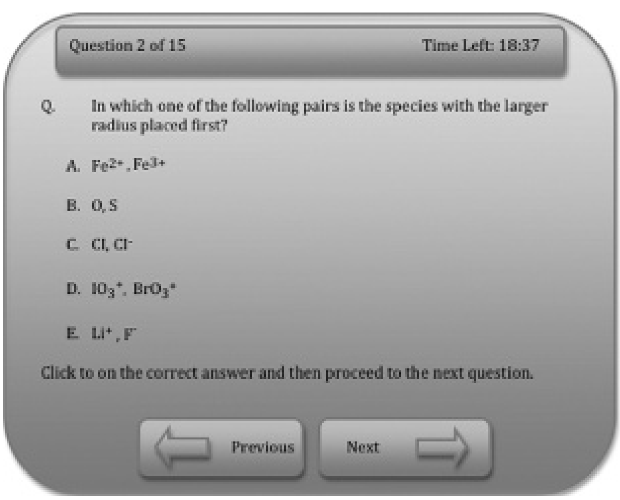


Figure 3.7 Example of a CAI Chemistry Exam Question.

Figure 3.8 Students Using CAI.

Among the findings from comparisons of CAI with standard classroom learning in military, academic and industry sectors were reductions of 24–54% in the time taken to learn. Technology costs aside, a 30% reduction in the time needed to learn would save the Department of Defense 15–25% of the US$4–5 billion it spends annually on specialized skill training (from novice to journeyman) (Fletcher, 2009, p. 72).

Today, the military continues to support CAI development and applications in the form of intelligent tutoring systems (ITS), and also through the development of digital learning objects.

Summary

Chapter 3 introduced behaviorism, the earliest theory of learning. Behaviorism also offers the simplest explanation of learning theories to date. It focuses exclusively on behavior and posits that a stimulus leads to a response: S–R.

The chapter explored the two major types of conditioning that characterize behaviorism. Classical conditioning, associated with Ivan Pavlov and his famous "dog experiments," held that behavior is conditioned to become a reflex response to a stimulus. Operant conditioning, the theory of B. F. Skinner, refers to the reinforcement of a behavior by a reward or a punishment.

There have been many critiques of behaviorism's rigid focus on behavior and its extreme rejection of the mind. Critiques of Skinner's research methods and the fact that his claims were based on very limited and restricted evidence also fueled the debate.

Pedagogical approaches associated with behaviorist learning theory were explored under three categories: reward and punishment, behavioral instructional design and taxonomies of learning. Behaviorism marks a time in American history when efficiencies of learning and mass education were being emphasized. Industrialization required a huge labor force that was literate and able to follow instructions accurately. The two world wars also emphasized military training that must be conducted quickly and intensely, with strict protocols and controlled behavior. Behaviorist pedagogies such as instructional design emphasized efficient behavioral control.

The rise of education technologies occurred within the behaviorist school of thought. Teaching machines, programmed instruction and CAI were invented within this context.

4
Cognitivist Learning Theory

I believe that at the end of the [20th] century the use of words and general educated opinion will have altered so much that one will be able to speak of machines thinking without expecting to be contradicted.

—Alan Turing, 1950

Chapter 4 covers the following topics:

- Context of cognitivism
- Cognitivist learning theory
    - Cognitive information processing
    - Schema theory
    - Gagné's instructional design
- Cognitivist learning pedagogy
    - Cognitivist instructional design
    - Schema techniques
- Cognitivist learning technology
    - Intelligent tutoring systems (ITS)
    - Artificial intelligence (AI).

Context of Cognitivism

Limitations in the behaviorist theory of learning began to be recognized by researchers in the early 1920s. The major problem for researchers was that behaviorism was unable to explain most social behaviors. For behaviorist scientists, what one cannot see or measure does not count. Believing was based "only" on seeing and the ability to measure what was seen. Anything else was not considered to be scientific or worthy of consideration.

Yet, as researchers and psychologists involved in the scientific study of learning began to realize, the power of the mind to influence or make decisions that are not directly related to an external stimulus was highly significant. It began to become clear that the mind did play a tremendous role.

Cognitivist Learning Theory

Cognitive theory emerged as an extension of and a reaction to behaviorist theory (although aspects of behaviorist theory remain evident in cognitivist theory). The rise of cognitivist learning theory was a response to behaviorism's rigid emphasis on the direct link between "stimulus and response." Cognitivist psychologists argued that the link between stimulus and response was not straightforward and that there were a number of other factors that intervened to mitigate or reduce the "predictability" of a *response* to a *stimulus* (Winn & Snyder, 1996). Nonetheless, cognitivism did not reject behaviorist science altogether but shifted the emphasis from external behavior to a focus on internal mental processes and to understanding how cognitive processes could promote effective learning. Elements from the behaviorist tradition were reshaped and incorporated into the cognitivist model of learning: stimuli became inputs and behaviors were the outputs.

Cognitivist theory was concerned with what comes between stimulus and response, seeking to understand the processes of the mind—the processes that the behaviorists had rejected. If behaviorism treated the organism as a black box, cognitive theory recognized the importance of the mind in making sense of the material with which it is presented. Cognitive learning theory was concerned with the mental processes that operated on the *stimulus*, and which intervened to determine whether or not a *response* was made and, if so, which response? Behaviorists believed that these mental processes could not be studied because they were neither observable nor measurable. However, despite its very strong influence on psychology and education, behaviorism could not eliminate consideration of mental states and words such as "thinking," "imagining," "conceptualizing" and others. Cognitivists argued that these processes were what constituted human learning and determined how we think and act, and hence must be studied. Hence, as shown in Figure 4.1, the key difference between behaviorist and cognitivist theories of learning was the importance accorded to what goes on between the stimulus or input and the resultant behavior. Cognitivists were interested in modeling the mental structures and processes that operated in the mind in order to explain behavior.

The rise of cognitive learning theory in the mid-20th century was influenced by developments in such fields as linguistics, neurology, psychology, education and the nascent field of computer science. Very soon cognitive theory replaced behaviorism as the major school of thought and experimental paradigm. In particular, this was accomplished because of, or in the context of, the invention of the computer. The computer had a powerful impact on cognitive theory. Metaphors such as "mind as computer" and "human information processing" came to dominate cognitivist research as related to educational practice.

A number of schools of thought are associated with cognitivist learning theory and are described below:

- Cognitive information processing (CIP)
- Schema theory
- Gagné's instructional design.

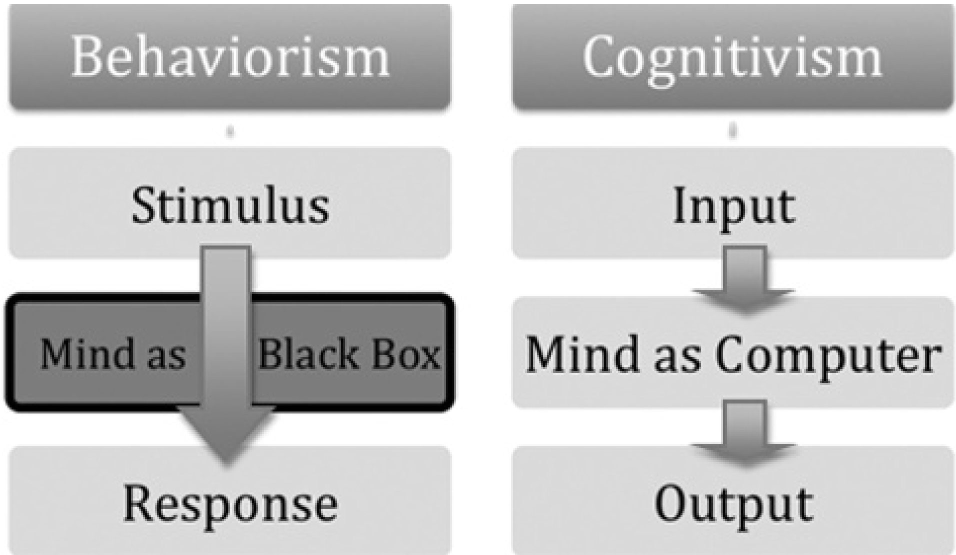


Figure 4.1 A General Overview of the Behaviorist and Cognitivist Foci.

Cognitive Information Processing (CIP)

Emerging as it did during the rise of cognitive science and computing, cognitivist learning theory absorbed and was influenced by the era. The notion of the brain as a computer which processes information is commonly associated with cognitivism, called cognitive information processing (CIP). Cognitivist researchers viewed the mind as a processor of information, much like a computer. Indeed, a powerful metaphor that has been used to characterize this approach is that of the "mind as computer." More infamous is the quotation by a founder of computer science, the Massachusetts Institute of Technology professor Marvin Minsky, who once described the human brain as "a meat machine—no more, no less."

Clark (2001) notes that while Minsky's phrase was "ugly," it also offered

> a striking image, a compact expression of both the genuine scientific excitement and the rather gung-ho materialism that tended to characterize the early years of cognitive science research. Mindware—our thoughts, feelings, hopes, fears, beliefs, and intellect—is cast as nothing but the operation of the biological brain, the meat machine in our head. (p. 7)

As a machine, the mind is made available for study and experimentation. In fact, according to this point of view, the mind is "best studied from a kind of engineering perspective":

> This notion of the brain as a meat machine is interesting, for it immediately invites us to focus not so much on the material (the meat) as on the machine: the way the material is organized and the kinds of operations it supports. … What we confront is thus both a rejection of the idea of mind as immaterial spirit-stuff and an affirmation that mind is best studied from a kind of engineering perspective that reveals the nature of the machine that all that wet, white, gray, and sticky stuff happens to build. (Clark, 2001, p. 7)

According to the CIP perspective, the human learner is a processor of information. The CIP model or metaphor holds that just as computers encode data and programs using memory and the central processing unit (CPU), so too the mind encodes information as symbols and procedures. The mind processes information; it works by cognitive information processing.

> Like the traditional cognitive view, the CIP model portrays the mind possessing a structure consisting of components for processing (storing, retrieving, transforming, using) information and procedures for using the components. Like the behavioral view, the CIP model holds that learning consists partially of the formation of associations. (Andre & Phye, 1986, p. 3)

Hence, the focus of CIP was to understand how the mind processes information. The CIP model influenced instructional design and hence had significant implications for cognitivist pedagogy. Moreover, CIP and MAC (mind as computer models) had a strong influence on cognitivist educational technologies such as intelligent tutoring systems (ITS) and artificial intelligence (AI).

Schema Theory

The concept of schema in cognitivist learning theory is related to mental representation and structural knowledge. Schema theory or schema perspectives hold that learning is easier if new subject matter is compared to existing knowledge and is structured or representational. Schema theory considers how our thinking uses various symbol systems, such as concept maps or graphic organizers, to help us learn and develop skills. Jonassen, Beissner, & Yacci (1993) write that schema theory

> contends that knowledge is stored in information packets, or schema that comprise our mental constructs for ideas. A schema for an object, event, or idea is comprised of a set of attributes or slots that describe and therefore help us to recognize that object or event. These slots contain relationships to other schema. It is the interrelationships between schema that give them meaning. (p. 6)

While there are many descriptions of what schemata are, Winn and Snyder (1996) note that all descriptions concur with the following characteristics:

1. Schema as memory structure: "It is an organized structure that exists in memory and, in aggregate with all other schemata, contains the sum of our knowledge of the world" (Winn & Snyder, p. 118). For example, we recall certain structures in a work of fiction, such as plots. And our memory of a book is typically based on this structure (What happened? When? To whom? By whom?), even when we cannot recall exact details or make errors in our recall.
2. Schema as abstraction: "It exists at a higher level of generality, or abstraction, than our immediate experience with the world" (Winn & Snyder, p. 118). We know that a cat is a mammal with four legs, two eyes, a tail and certain habits. The specific color or size of a particular cat is at a different level.
3. Schema as network: "It consists of concepts that are linked together in propositions" (Winn & Snyder, p. 118). The network consists of nodes and links. An example cited by Winn and Snyder is the schema of a face. Not a particular or specific face, but a human face in general, in which the head (a sort of oval) is the central node, eyes (different smaller ovals) are linked to one another and to a nose and mouth, which are described by their relationships of size, location and shape. A mouth is always below the nose and is bigger than the eyes. A nose is always below the eyes and above the mouth. These nodes are linked and together form a face.

4. Schema as dynamic structure: A schema is not immutable and changes as we learn new information through instruction or through life experience. Schema theory proposes that our knowledge of the world is constantly interpreting new experience and adapting to it. These processes, which Piaget (1968) has called *assimilation* and *accommodation*, and which Thorndyke and Hayes-Roth (1979) have called *bottom-up* and *top-down* processing, interact dynamically in an attempt to achieve cognitive equilibrium without which the world would be a tangled blur of meaningless experiences. (Winn & Snyder, p. 118)
5. Schema as context: "It provides a context for interpreting new knowledge as well as a structure to hold it" (Winn & Snyder, p. 119). Schemata determine how we interpret new information, and even influence how we explore our environment. Anticipatory schemata direct our exploration of the environment and which sources of information we select.

Gagné's Instructional Design

Robert M. Gagné (1916–2002) was an American instructional psychologist best known for his 1965 book, *The Conditions of Learning*, and for his contribution to instructional design theory. Gagné's theory of instruction evolved from behaviorist roots to embrace the cognitivist information processing model. *The Conditions of Learning* reflected behaviorist theory; the fourth edition of this book, published in 1985, is associated with cognitivist theory in general and CIP in particular. Gagné's ideas and his writings were revised based on his research and instructional practice. In 1996, Gagné (with Karen Medsker) published *The Conditions of Learning: Training Applications*.

Gagné's theory extended beyond CIP to a certain degree, in that he incorporated empirical data on how teachers behave in the classroom. His early work was predominantly as a psychologist with the US military, training air force personnel. Overall, he spent about 50 years engaged in military research on training. The issues that he addressed were how to determine what skills and knowledge are required for someone to perform a particular task or job effectively, and how to determine how these requirements might best be learned. Gagné's work centered on instructional design and the prescription of a didactic pedagogy based on individualized learning. Instruction was viewed as the transmission of information. The role of the student was to respond to the stimuli effectively. The role of the instructor was to design and present the correct and appropriate stimuli to elicit the appropriate student behavior.

Gagné's taxonomy of learning outcomes has similarities to Bloom's taxonomy of cognitive, affective and psychomotor outcomes, in that both focused on learning outcomes. A taxonomy is a systematic classification of something. Taxonomies were being developed in the sciences, such as taxonomies of mammals, fossils, birds, living fauna or flora. Creating a taxonomy of learning outcomes was in keeping with this scientific ethos. Instructional design required a way of identifying and organizing learning outcomes, in order to be able to specify the behaviors required to achieve these outcomes. Both Bloom and Gagné believed that it was important to create a system of classifying learning into categories of domains.

Gagné's theory of instruction comprises three major components, each with subcomponents:

1. A taxonomy of learning outcomes:

    a. verbal information;
    b. intellectual skills;
    c. cognitive strategies;
    d. attitudes;
    e. motor skills.

TABLE 4.1 Gagné's Theory of Instruction

Learning Outcomes	*Specific Conditions for Learning*	*Events of Instruction*
• Verbal information • Intellectual skills • Cognitive strategies • Attitudes • Motor skills	• Verbal information • Intellectual skills • Cognitive strategies • Attitudes • Motor skills	• Gaining attention • Informing learner of objective • Presenting stimulus • Providing guidance • Eliciting performance • Assessing performance • Enhancing retention and transfer

2. Specific conditions for learning each outcome:
    a. conditions for learning verbal information;
    b. conditions for learning intellectual skills;
    c. conditions for learning cognitive strategies;
    d. conditions for learning attitudes;
    e. conditions for learning motor skills.
3. Nine events of instruction (methods and procedures to facilitate specific learning processes):
    a. gaining attention;
    b. informing the learner of the objective;
    c. stimulating recall of prior learning;
    d. presenting the stimulus;
    e. providing learning guidance;
    f. eliciting performance;
    g. providing feedback;
    h. assessing performance;
    i. enhancing retention and transfer.

Gagné identified five categories of learning outcomes, each category leading to a different type or class of human performance. His intention was to specify the learning outcomes in order to design the instructional activities that could achieve those outcomes.

Gagné's "conditions of learning" are a key aspect of his instructional design theory. Gagné and Driscoll (1988) refer to them as the building blocks for instruction, because of their critical influence on learning the various outcomes. Each of the five learning outcomes has associated conditions of learning: different learning outcomes call for different learning conditions. These are discussed in more detail in the Cognitivist Learning Pedagogy section that follows.

Gagné's nine events of instruction tie his instructional theory together. These events are intended to promote the transfer of knowledge or information through the stages of memory. Gagné's events of instruction are based on the CIP perspective of learning.

Cognitivist Learning Pedagogy

Winn and Snyder (1996) provide a thoughtful and important reminder about theory and practice in general, and with respect to cognitivism in particular:

> History teaches us that theories change more readily than practice. Therefore when researchers started to develop cognitive theories that compensated for the inadequacy of behaviorism

> to explain many aspects of human behavior, the technologies and practices by means of which psychological theory is applied changed more slowly, and in some cases not at all. The practices recommended by some schools of thought in instructional design are still exclusively behavioral. (p. 112)

There are many theoretical and pedagogical links between behaviorism and cognitivist learning theory, and many key theoreticians and researchers can be associated with both schools. This is especially true of instructional design. As noted in Chapter 1, Robert Gagné, the major name associated with instructional design theory, was initially a member of the behaviorist learning school of thought before his association with cognitivism.

Cognitivist Instructional Design

Cognitivist instructional design proceeded from a premise of the predictability of human behavior, similar to the behaviorist perspective. Hence, instruction was designed to be prescriptive. And given the belief in predictability, it was assumed that if a certain stimulus resulted in a particular response or outcome, it would do so again and again. The role of the instructional designer was to identify the learning stimuli that would lead to certain outcomes. By identifying and prescribing the appropriate stimulus and related pedagogical strategies, the instructional designer could ensure that students would learn the intended skills or set of subskills that would result in overall mastery of the skill. This, of course, implied a huge requirement, given the very diverse and extensive range of skills that exist in the real world. It required listing and classifying *all* human tasks.

As noted above, Gagné's theory of instruction identified a taxonomy of learning outcomes, specific conditions for learning each outcome and nine events of instruction (methods and procedures to facilitate specific learning processes). Gagné subdivided the nine events of instruction into the following procedures:

1. Gaining attention: this involves some form of stimulus change to get the attention of the student, such as the teacher calling the students to attention, the computer software flashing a message.
2. Informing the learner of the objective: the instructor tells the students what they will be able to do after learning.
3. Stimulating recall of prior learning: the instructor assists the student in recalling relevant prior knowledge to apply to new situations by reminding them.
4. Presenting the stimulus: the instructor will provide an example, a model, a reading or give directions as a stimulus for student information acquisition or motor skills to facilitate pattern recognition.
5. Providing learning guidance: the instructional activities promote the encoding of the learning into long-term memory in a meaningful way.
6. Eliciting performance: this step has students demonstrate their learning.
7. Providing feedback: feedback can relate to helping students correct any incorrect answers or helping them to improve their current skill.
8. Assessing performance: formal assessment can be conducted through various techniques such as testing, portfolios, performances or projects.
9. Enhancing retention and transfer: this can be facilitated through mechanisms such as repeating or iterating events 5 or 6 and 7 as appropriate. Software simulations also assist by demonstrating the consequences of students' problem-solving or decision-making. (Gagné, 1985)

Gagné's instructional theory has had significant influence and prominence in educational practice, primarily in the field of adult and military training. The specificity of the analyses and classification has provided instructional designers with explicit steps to incorporate into training procedures. Gagné's instructional theory was, nonetheless, the most linked to educational practice among cognitivist theorists.

Schema Techniques

Schemata, as discussed earlier in this chapter, are a hypothetical construct, which is a metaphor for describing the ways that humans construct and store knowledge. Jonassen et al. write: "Because structural knowledge has been tied to memory processes and problem-solving, it seems useful to prescribe instructional and learning strategies for fostering the acquisition of structural knowledge" (1993, p. 12). The authors suggest a number of explicit methods for conveying structural knowledge that can improve learning and performance of higher-order mental operations such as problem-solving. Many of these techniques are included in Table 4.2.

Cognitivist Learning Technology

The field of "educational technology" emerged during the behaviorist period and gained increased importance and influence for cognitivist researchers and instructional designers. Computers were the key learning technology for cognitivist learning theorists. Key examples include:

- intelligent tutoring systems;
- artificial intelligence.

Intelligent Tutoring Systems

Intelligent tutoring systems (ITS) refer to a didactic, content-specific instructional technology. ITS have been in existence since the 1970s. The precursors of ITS were early mechanical systems such as Charles Babbage's vision of a multipurpose computer which he developed, in principle, in 1834 as the *analytic engine*, as well as Pressey's mid-1920s *teaching machines* or "intelligent" machines which used multiple-choice questions submitted by the instructor. In the 1970s, computer-assisted instruction (CAI) emerged as an instructional method based on a systematic instructional approach administered on a computer. In CAI the computer evaluates whether the student's response is right or wrong, and then branches the student into either moving ahead (with appropriate feedback) or into corrective action such as reviewing the earlier material or presenting a simpler question. Branching is designed (coded) by the instructional designer into the program: if the student's answer is correct, then the student advances to the next question. If the student's response is incorrect, then remediation is invoked. This is behaviorist instructional design.

Hardware and software have evolved at tremendous rates since the 1970s. As computers became more sophisticated, so too did instructional applications. Shute and Psotka (1996, p. 571) write that increasingly complex branching capabilities in CAI led to what became known as ICAI (or

TABLE 4.2 Schema Pedagogies

- Semantic maps
- Causal interaction maps
- Concept maps
- Semantic features analysis
- Cross-classification tables
- Advance organizers
- Graphic organizers

Intelligent CAI) and eventually to ITS. It is a continuum from linear CAI to the more complex branching of ICAI and then ITS, although Shute and Psotka note that this does not mean that the continuum represents a worst-to-better progression.

Branching is a common and key characteristic of CAI and ITS, and reflects the complexity of knowledge and multiple pathways of a curriculum. However, the quality of branching, and its complexity, does distinguish ITS from CAI. Whereas CAI is content-free, ITS are based on specific knowledge domains that are taught to the individual students by the computerized tutor.

Shute and Psotka (1996) provide a generic depiction of the process:

> A student learns from an ITS primarily by solving problems—ones that are appropriately selected or tailormade—that serve as good learning experiences for that student. The system starts by assessing what the student already knows, the *student model.* The system must concurrently consider what the student needs to know, the *curriculum* (also known as the *domain expert*). Finally the system must decide which curriculum element (unit of instruction) ought to be instructed next and how it shall be presented, the *tutor* or inherent teaching strategy. From all of these considerations, the system selects, or generates, a problem, then either works out a solution to the problem (via the domain expert) or retrieves a prepared solution. The ITS then compares its solution, in real time, to the one the student has prepared and performs a diagnosis based on differences between the two. (p. 574)

Key constructs that guide ITS design are thus:

- knowledge of the domain (domain expert);
- knowledge of the learner (student model);
- knowledge of teaching strategies (tutor).

Figure 4.2 ITS Training (Photo Courtesy of the US Army).

However, there are many challenges to the cognitivist views of learning and learning technologies. Shute and Psotka (1996) suggest that:

> One reason that ITS may disappear in the future is that, while many researchers agree that intelligence in an ITS is directly a function of the presence of a student model, the student model may, in fact, be the wrong framework around which to build good learning machines. (p. 591)

Second, there are problems with the concept of machine "intelligence." Intelligence is associated with awareness; the term "intelligent tutoring system" can be viewed as misleading or inappropriate and promising far more than it can or has delivered. Shute and Psotka cite Gugerty's (1993) view that ITS may promise too much, deliver too little and constitute too restrictive a construct:

> There is a sense in which the goals of traditional intelligent tutoring systems are both too ambitious and too narrow. Most traditional ITS … are designed to provide tutoring in a stand-alone setting. … This ambitious goal requires that the ITS handle all aspects of the very difficult task of tutoring, including expert problem solving, student diagnosis, tailoring instruction to changing student needs, and providing an instructional environment. … On the other hand, the goal of developing very intelligent stand-alone ITS is narrow in the sense that it limits our conception of how intelligence can be incorporated into computer-based training and education. (Shute & Psotka, 1996, p. 591)

Other researchers in ITS began to critically reconsider their own work. One extensive research program, the Highly Interactive Computing Environment (HiCE) group at the University of Michigan, involved using ITS to tutor students who were learning to program. Studies were conducted on student modeling, categorizing bugs and helping students to identify and fix the bugs. However, after 10 years, the researchers began to question their assumptions about learning, and began to shift from an objectivist to a constructivist perspective. Rather than continue to view computer bugs as deviations from the expert's correct solution, and to try to bring the student's view into congruence or accord with that of the expert, the HiCE group began to view learning as a process of enculturation into a knowledge community. They reassessed their definition of a student model to that of a community: "Instead of trying to model students, we are now trying to provide students with the tools, facilities and communities they need to support the development of models for their own uses" (Sack, Soloway, & Weingrad, 1994, p. 373).

Other challenges to ITS were on the horizon by the 1980s and 1990s. The rise of the internet foreshadowed a huge paradigmatic shift. ITS developers had not anticipated or prepared for this technological revolution. The problem was solved temporarily by posting ITS computer-based training and courseware online, on the internet. This resulted in what is known as online computer-based training, or online courses (discussed in Chapter 6). Online course-authoring tools enabled instructional designers to create their own courseware. Traditional courseware requires computer programmers to code the software; course-authoring tools attempt to simplify the programming requirements so that content experts can author their own courseware.

However, ITS technology has not been adopted within the larger educational market, and even within the smaller training market the field of ITS has experienced profound problems as Shute and Psotka (1996), among others, have noted:

> We can see the seeds of discontent growing. Go to any ITS-related conference and notice how researchers in the field have begun to discontinue using the term "ITS." Instead, in a show of semantic squirming, they refer to advanced automatic instructional systems (formerly,

> ITS) as: interactive learning environments, cognitive tutors, individualized teaching systems, computer-assisted learning, automated instructional support systems, computer-based learning environments, immersive tutoring systems, knowledge communication systems, computer tools, and so on.
>
> Not only is the ITS construct too ambitious, but there is no universally accepted definition of what comprises computer intelligence. (p. 595)

A significant concern with the development of learning theory, pedagogy and technologies by both behaviorists and cognitivists was that the researchers and scholars had little contact with educational practice or practitioners. Pavlov was a medical physiologist who focused on reflexes related to digestive systems while Skinner worked with animals in research laboratories. While behaviorist approaches based on the carrot and the stick dominated classrooms at all levels of education (and still do), these are, nonetheless, very broad interpretations of the stimulus–response activities of classical behaviorism or operative conditioning. Behaviorist learning theorists did not take real classroom learning or educational practice into consideration.

Cognitivist learning theorists were similarly divorced from educational practice, with the exception of Gagné who spent 50 years working with military training as a psychologist and was subsequently involved with military training research. His instructional design theory and processes have particularly influenced the field of training. Classroom applications in K–12 or higher education were not, however, significantly influenced by Gagné's instructional design model.

The technologies developed by cognitivist researchers and developers were similarly isolated from classroom realities; they were never adopted or considered for classroom applications. Shute and Psotka observe: "There are actually very few ITS in place in schools, yet they exist in abundance in research laboratories. We need to move on" (1996, p. 595).

Artificial Intelligence (AI)

The invention of computers after World War II generated anticipation of astounding possibilities for computer programs to be capable of human-like intelligence. In 1950, Alan Turing reflected on the potential of computer programs to simulate the human mind. Turing is known as the inventor of the first computer, in 1936, although his computer was on paper only. The Turing computer was a tape that could store a symbol or simple instructions and a head that could read the instructions and perform very simple operations (read the symbol, select a new symbol, move it left or right). Despite its simple capabilities, Turing argued that his machine could realize anything that can be achieved from operations. In 1950, he argued that the mind itself was the result of similar operations (at the neural level). He is thus viewed as the creator of artificial intelligence studies. Turing (1950) wrote:

> Instead of trying to produce a programme to simulate the adult mind, why not rather try to produce one which simulates the child's? If this were then subjected to an appropriate course of education one would obtain the adult brain. Presumably the child-brain is something like a note-book as one buys it from the stationers. Rather little mechanism, and lots of blank sheets. (Mechanism and writing are from our point of view almost synonymous.) Our hope is that there is so little mechanism in the child-brain that something like it can be easily programmed. The amount of work in the education we can assume, as a first approximation, to be much the same as for the human child. (p. 436)

The AI movement originated with scholars such as Alan Turing, Marvin Minsky and Allen Newell, who all believed that the development of computers that could "think" like humans was just around the corner. The major constraint, they believed, was the size of current computing

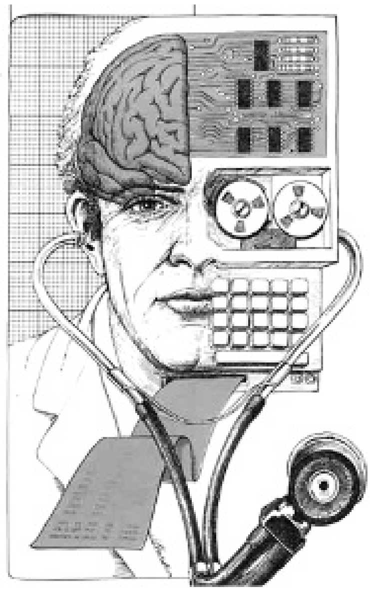


Figure 4.3 Artificial Intelligence as Conceptualized in Mid-20th Century.

power. Bigger and faster computers should be able to solve the problem and achieve human-like cognitive performance. Computers would be able to think, and they would thus be able to instruct.

The AI movement had emerged in the 1950s, in the early post-war period. Thousands of American GIs had returned home from World War II and were going to college on the GI Bill (this provided returning war veterans with funding to cover tuition and expenses for attending college or trade schools). The impact on educational institutions was unprecedented growth. New ways to meet the demand for education were a high priority. The use of computers for instruction seemed like one obvious solution. Efficient instruction could be met by using computing machines. It could also be facilitated through efficient instructional pedagogies.

During the 1970s and 1980s, AI researchers continued to optimistically believe in the imminent viability of computer intelligence. The rapid growth in computing power and capabilities seemed to promise that the goal of thinking computers was nigh. However, the problems began to prove far greater than simply the need for more computer memory or speed. A crisis in the movement was triggered not only by the technological problems but in the very definition and implementation of computer intelligence. As noted earlier in the chapter, there was no universal definition of what constitutes computer intelligence. The AI movement lost its impetus for the moment, although research continued with ITS.

Brent Wilson (1997b) acknowledged a growing disaffection with theories of AI as well as with instructional design (ID). As a scholar engaged in ID studies, he found a similar sense of chaos and lack of direction among adherents and researchers. Writing about ID, Wilson states: "Artificial intelligence right now is facing some of the same crises we are confronting. … A growing number of AI researchers have lost faith in traditional views of the representability of knowledge" (1997b, p. 77). He concludes: "In summary, ID theory, with its prescriptive orientation toward both procedure and product, lies in conceptual limbo" (1997b, p. 70). But as we will read in Chapters 6 and 7, massive commercial, military and scientific investments in AI over the past two to three decades fueled an exponential growth in computing power and led to the dramatic, accelerating growth of AI.

In the 1960s and 1970s, social reform movements were impacting society and education in the United States. New perspectives on learning based on constructivist epistemology and theory were coming from Europe and began to strongly influence American education. It was a time of change and of changing perceptions of the role of the student and of the citizen. Theories of constructivist learning generated significant researcher as well as teacher interest. Piaget's theories were taking hold and at the same time Bruner was introducing the ideas and writings of Lev Vygotsky, who presented an approach to social constructivism, perspectives related to active learning and student-centered models of learning.

Summary

Cognitivism emerged as a reaction to what had become viewed as simplistic and rigid emphasis by behaviorists on predictive stimulus–response. Cognitivism recognized that reinforcement did impact on the probability of certain behaviors, but was in general interested in theorizing and modeling the mental structures and processes that could explain human behavior. The emphasis was on the mental or cognitive models. The rationale was that if it were possible to devise accurate models, then it would be possible to create and/or prescribe learning events to address more complex behaviors, such as problem-solving and decision-making.

Nonetheless, cognitivists shared certain fundamental views and pedagogies with behaviorists. Cognitivist learning theory was instructor-centered: the focus was on the instructor and instructional design. Knowledge was to be transmitted to the learner, either by the instructor or by the instructional software. Cognitivism presupposed that the primary role of the learner is to assimilate what the teacher presents, and thus it retained a didactic model. Both behaviorism and cognitivism shared a similar epistemology: objectivism. This epistemology held that knowledge was known by the instructor who would predigest and then transmit it to the student. Cognitivism, like behaviorism, focused on individualized learning perspectives and procedures.

There is some blurring between the behaviorist theoretical school and the cognitivist theory of learning, because some transitions were initiated or led by those who were participants in the previous school of thought. Still, cognitivism was a very strong field in educational psychology, and remains so.

Nonetheless, by the 1970s a new theory of learning was about to challenge this school of thought: constructivism.

5
Constructivist Learning Theory

In hindsight, the reason for my students' poor performance is simple. The traditional approach to teaching reduces education to a transfer of information … However, education is so much more than just information transfer, especially in science. New information needs to be connected to pre-existing knowledge in the student's mind. Students need to develop models to see how science works. Instead, my students were relying on rote memorization. Reflecting on my own education, I believe that I also often relied on rote memorization. Information transmitted in lectures stayed in my brain until I had to draw upon it for an exam. I once heard somebody describe the lecture method as a process whereby the lecture notes of the instructor get transferred to the notebooks of the students without passing through the brains of either. That is essentially what is happening in classrooms around the globe.

—Eric Mazur, 2009

Chapter 5 will cover the following topics:

- Context of constructivism
- Constructivist learning theory
  - Piaget
  - Vygotsky
- Constructivist learning pedagogy
  - Active and authentic learning
  - Learning-by-doing
  - Scaffolded learning
  - Collaboration

- Constructivist learning technology
  - Construction kits and microworlds
  - Scaffolded intentional learning environments
  - Learning networks or telecollaboration
  - Online learning and course delivery platforms.

Context of Constructivism

Constructivism refers to a theory or set of theories about learning that emerged in Europe and were introduced to the United States in the 1970s, during a period of social reform and civil rights movements and challenges to the "old" order and its hierarchies. The social movements had a strong impact on education. Moreover, cognitivist views had come under criticism. Educational researchers and practitioners began to reject the notion that humans could be programmed like robots, to always respond in the same way to a stimulus. In fact, it became recognized that the mind plays an enormous role in how people act when learning, but that role is not directly comparable to a software program based on discrete steps to consume and process information as put forward by cognitivist theorists. Constructivism—particularly in its "social" forms—suggests that the learner is much more actively involved in a joint enterprise with the teacher and with peers in creating (constructing) knowledge.

Constructivist Learning Theory

Constructivism refers both to a learning theory (how people learn) and to an epistemology of learning (what is the nature of knowledge). Both the constructivist theory of learning and constructivist epistemology are generally quite distinct from behaviorism and cognitivist theories of learning, although some theorists are associated with more than one of these theories. Moreover, the constructivist epistemology is reflected in other learning theories, not only constructivist theory. Thus, it is important to keep in mind that the term constructivism is used in two distinct ways, to refer to a theory and to an epistemology.

Constructivist theory posits that people construct their own understanding and knowledge of the world through experiencing the world, and reflecting on those experiences. Our encounters with new ideas, new things and new perspectives require that we reconcile the new with our prior understanding: Does the new fit with our previous understanding and if not, do we discard it, integrate it with our existing views or change our existing beliefs? This process is one of asking questions, exploring, engaging in dialogue with others and reassessing what we know. As such we are active creators and constructors of our own knowledge.

Moreover, as discussed in Chapter 1, the constructivist epistemology, regarding what is the nature of knowledge, is very distinct from the objectivist epistemology that underlies behaviorist and cognitivist theory. In the constructivist perspective, knowledge is constructed by the individual through his or her interactions with the community and the environment. Knowledge is thus viewed as dynamic and changing, constructed and negotiated socially, rather than something absolute and finite. This has important implications for teaching and learning, and will be explored further in the section on Constructivist Pedagogy.

Constructivist learning theory, like behaviorist and cognitive learning theories, is not one unified entity. Rather it is an umbrella term representing a range of perspectives based on two or more rather distinct positions while sharing some common denominators. Duffy and Cunningham (1996) clarify the basis of constructivism, noting that despite the diversity of views encompassed in the concept of constructivist learning theory there seems to be a general consensus that "learning is an active process of constructing rather than acquiring knowledge," and that "instruction is a process of supporting that construction rather than communicating knowledge" (p. 177).

In the 20th century, the major theorists associated with constructivist approaches were Jean Piaget and Lev Semyonovich Vygotsky. Two major camps or perspectives are associated with constructivism, one with each theorist:

- "Cognitive constructivism" is how the individual learner understands the world, in terms of biological developmental stages.
- "Social constructivism" emphasizes how meanings and understandings grow out of social encounters.

Cognitive constructivism focuses on the individual learner and emerged from Piaget's thinking and research. Social constructivism emerged from the work of Vygotsky and emphasizes the social essence of knowledge construction.

Piaget

Jean Piaget (1896–1980), a Swiss-born professor of psychology and student of biology, devoted his life to the question of cognitive development, and particularly to classifying the stages of human development. Piaget posited that humans learn through the construction of progressively complex logical structures, from infancy through to adulthood. Humans, in his view, learn through the construction of one logical structure after another. Piaget also concluded that the logic of children and their modes of thinking are initially entirely different from those of adults, and that successive knowledge-building activities increase in depth and complexity as humans move from one stage to another in their development: age-based stages. Learning followed development: it occurred according to the child's age and stage of development. Development ceases as the child reaches early adulthood, according to Piaget's four stages of development, and he did not discuss adult learning.

Piaget was not only a psychologist but also a biologist. He strongly defended and promoted the scientific method, and he believed that the scientific approach was the only valid way of gaining access to knowledge. This conviction influenced Piaget's perspectives on psychology, and led him to declare: "This made me decide to devote my life to the biological explanation of knowledge" (Munari, 1994). Munari, who collaborated with Piaget from 1964–1974, wrote of Piaget that

> With regard to his work as a researcher and university teacher, the constant concern influencing and guiding his work and, indeed, his entire life was that of winning recognition, especially by his colleagues in physics and the natural sciences, for the equally *scientific* nature of the human sciences and, more specifically, of psychology and epistemology. His attitude and his involvement in the field of education led him quite naturally to champion the pupil's active participation as the royal road to the scientific approach in school. (Munari, 1994)

Piaget is also identified with genetic epistemology or genetic constructivism, what he referred to as "a kind of embryology of intelligence" (cited in Munari, 1994). As Munari (1994) notes:

> In particular, the basic postulate of genetic psycho-epistemology whereby the explanation of all phenomena, whether physical or social, is to be sought in one's own mental development and nowhere else, helped to give the historical dimension a new role, in teaching methods as well as in general debate on education. Every theory, concept or object created by a person was once a strategy, an action, an act.

Piaget's concept of genetic epistemology reflects the span of his interests in the areas of biology, philosophy and child psychology, all related to how the child comes to know his or her world. Genetic epistemology reflects Piaget's work in studying knowledge and, in particular, the origins or genesis of knowledge, and reflects his interest in both the philosophy (epistemology) and psychology of knowledge.

George Bodner, professor of chemistry, whose 1986 article "Constructivism: A Theory of Knowledge" examines the use of constructivism in the classroom, noted:

> Piaget believed that knowledge is acquired as the result of a life-long constructive process in which we try to organize, structure, and restructure our experiences in light of existing schemes of thought, and thereby gradually modify and expand these schemes. (p. 875)

Bodner quotes a passage from Piaget (1968) in which Piaget describes the period between birth and the acquisition of language as a mini-revolution; a Copernican revolution in our personal universe, as our understanding develops from total self-centeredness to being a participant in a social universe.

> At eighteen months or two years this "sensorimotor assimilation" of the immediate external world effects a miniature Copernican Revolution. At a starting point of this development the neonate grasps everything to himself—or, in more precise terms, to his own body—whereas at the termination of this period, i.e., when language and thought begin, he is for all practical purposes but one element or entity among others in a *universe that he has gradually constructed himself*, and which hereafter he will experience as external to himself. (Piaget, quoted in Bodner, 1986, p. 875; emphasis added)

All humans pass through the same stages of cognitive development at around the same age, according to Piaget. He believed that children pass through a largely invariable and universal sequence of four stages:

1. *Sensorimotor* (birth to approximately 2 years of age): a period in which infants begin to construct an understanding of the world through the senses and through movement. Sensory experiences (seeing, hearing) are coordinated with physical, motor actions. Reflexes become intentional actions such as grasping. The infant begins to develop an understanding that objects can exist externally, even if they cannot be seen. The infant also begins to demonstrate goal-directed behavior, such as kicking a ball.
2. *Preoperational* (2–7 years): by observing children at play Piaget was able to demonstrate that around the age of 2 years, the child exhibits a qualitatively new stage of development, which he termed preoperational. At the preoperational stage of development the child is able to mentally act on objects and to represent objects using words and drawings, but is not yet able to think through actions. The child also engages in collective monologue with other children; each child is talking but not interacting with other children. Children are considered egocentric at this stage—they assume that others share their point of view.
3. *Concrete operational* (7–11 years): by around the age of 7, a child is able to use logic appropriately and to solve actual problems, although not abstract problems. This is the stage of concrete operations, best learned through hands-on learning and discovery while working with tangible objects.
4. *Formal operational* (12+ years): This stage commences at around 12 years of age (puberty) and continues into adulthood. In this stage, individuals move beyond concrete experiences

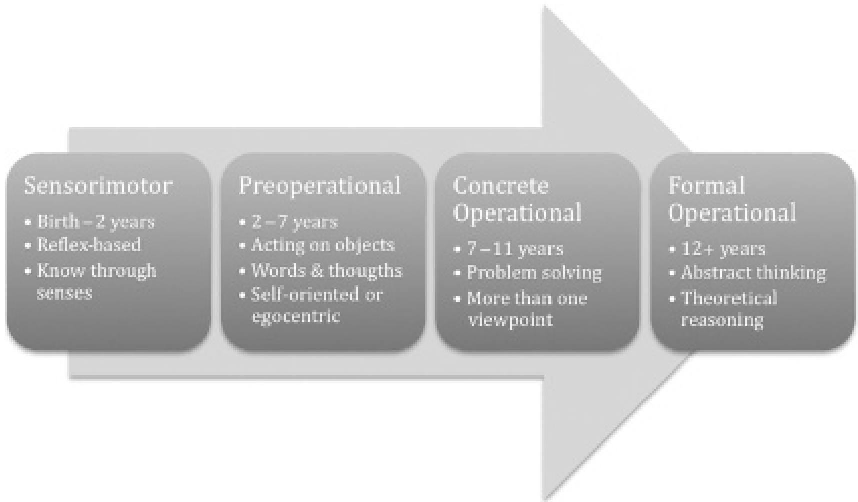


Figure 5.1 Piaget's Stages of Cognitive Development.

> and begin to think abstractly, reason logically and draw conclusions from the information available, as well as apply all these processes to hypothetical situations. During this stage the young adult is able to understand such things as love, entertain possibilities for the future and become more aware of social issues. (Santrock, 2008, pp. 221–223)

These four stages of development are posited by Piaget as the psychological states that children pass through as they grow up. Related to these four stages is the mechanism by which children move from one stage to the next. Piaget's concept of constructivism relates to his studies of how knowledge is internalized and how people learn. Humans, according to Piaget, internalize knowledge through experience and make sense of these experiences through adaptation involving the following processes: *assimilation*, *accommodation* and *equilibration/disequilibration*. It is through these three processes that we learn, outgrow some ideas and adopt new ones. These concepts reflect both Piaget's model of intellectual development and his constructivist theory of knowledge.

Assimilation occurs when a child or person comes across a new object or event and makes sense of it by assimilating information about the object (for example, learning a new word). Assimilation involves applying a pre-existing mental structure to interpreting sensory data. This is true of the reflex action of a newborn to suck, and is a constant process throughout life. Disequilibration occurs when an action cannot be assimilated into pre-existing structures or when we cannot achieve the goals we seek (sucking a thumb rather than a nipple does not lead to food or when what we learned does not accomplish our goal). Accommodation occurs when the person realizes that the activity does not achieve the expected result, and that existing schemes or operations must be modified. We must accommodate new ways of making sense of an object or event. Constructivism is meaning-making through activity, according to one's age and stage of development.

An instructor, for example, seeks to stimulate conceptual change by challenging a student's existing concepts in order to create cognitive disequilibration. The student will try to restore equilibrium or resolve the problem. Through a process of disequilibration and requilibration, the student constructs new cognitive structures.

Piaget was concerned with epistemology and the question of how knowledge is acquired. Rather than view knowledge as matching reality, as in the objectivist epistemology, Piaget held that knowledge is constructed as the learner seeks to find an equilibrium between the biological processes of assimilation and accommodation, through the cognitive functions of organization and adaptation (internal self-regulating mechanisms).

The basic tenet of Piaget's constructivism is that knowledge is constructed in the mind of the learner. Whereas the traditional (objectivist) view of knowledge is that of a *match with reality*, Piaget's constructivist view is that knowledge is a *fit with reality*. The learner is not an empty vessel to be filled with the knowledge of the teacher, but an active organism creating meaning through contact and interaction with the external world.

Piaget distinguished among three types of knowledge that children acquire: physical, logico-mathematical and social knowledge (Piaget, 1969):

1. Physical knowledge is associated with empirical knowledge, which is knowledge about physical objects available from the perceptual properties of objects: size, color, thickness, texture, taste and sound. For example, a ball bounces whereas glass breaks when dropped on the floor.
2. Logico-mathematical knowledge is related to abstract knowledge about objects, such as number, volume, mass, weight, time, speed and size. Comparing the different rate of bouncing between a basketball and a baseball dropped on the floor is an example of logico-mathematical knowledge.
3. Social knowledge is culture specific and can only be learned in one's own culture, through actions on or interactions with people. Examples include cultural symbol systems, music, history and language. Playing in a basketball competition on a day called Saturday exemplifies social conventions about dates and sports.

Understanding the types of knowledge that Piaget identified is important but not easy. As Ernest von Glasersfeld, also a Piagetian scholar, writes:

> Any serious attempt to come to terms with Piaget's epistemological beliefs runs into three formidable obstacles. First, the simple fact that during his productive lifetime—well over 60 years—he wrote more than any one person could keep up with; and his ideas, of course, developed, interacted, and changed in more and less subtle ways. Second, as Piaget himself is reputed to have said, he spoke one language to biologists, another to psychologists, and yet another to philosophers; and one could add that, apart from these, he invented a private one to speak about mathematics. Third, although he never ceased to praise the virtue of "decentration"—the ability to shift perspective—as a writer, it seems, he did not often try to put himself into his readers' shoes. His passionate effort to express his thoughts in the greatest possible detail impedes understanding as often as it helps it. Even the best intentioned reader is sometimes reduced to a state of exhausted despondence. Yet, I have not the slightest doubt that it is worth struggling to overcome these obstacles, because it can lead to an interpretation that provides a view of human knowledge and the process of knowing which, it seems to me, is more coherent and more plausible than any other. (von Glasersfeld, 1982, p. 612)

von Glasersfeld explains what he considers to be the key point of cognitive constructivism. "For a constructivist," he writes,

> that is how it has to be. From that perspective there is no way of transferring knowledge every knower has to build it up for himself. The cognitive organism is first and foremost an organizer

> who interprets experience and, by interpretation, shapes it into a structured world. That goes for experiencing what we call sensory objects and events, experiencing language and others; and it goes no less for experiencing oneself. (von Glasersfeld, 1982, p. 612)

As with any major school of thought there are many critiques of Piaget. von Glasersfeld referred to the obstacles of understanding Piaget, given his vast number of publications. In addition, as von Glasersfeld also noted, Piaget spoke many disciplinary languages and studied and wrote about many fields, and this in itself causes confusion and obstacles for readers.

Seymour Papert, who introduced constructivist computing to school children, notes that Piaget's real interests and contributions were in epistemology, an area overlooked by educators. Papert wrote about Piaget in *Time* magazine's 1999 special issue on the "Century's Greatest Minds":

> Although every teacher in training memorizes Piaget's four stages of childhood development, the better part of Piaget is less well known, perhaps because schools of education regard it as "too deep" for teachers. Piaget never thought of himself as a child psychologist. His real interest was epistemology—the theory of knowledge …
>
> The core of Piaget is his belief that looking carefully at how knowledge develops in children will elucidate the nature of knowledge in general. Whether this has in fact led to deeper understanding remains, like everything about Piaget, controversial. (1999, p. 105)

However, more fundamental theoretical arguments have also been raised. One such critique comes from Howard Gardner, a psychologist at Harvard University and author of many books about multiple intelligences. In response to the question put to many well-known scholars and public figures in 2008: "What did you change your mind about?," Gardner wrote that he changed his mind about Piaget's theory of learning. The focus of Gardner's thought piece "Wrestling with Jean Piaget, My Paragon," is presented below.

> I thought that Piaget had identified the most important question in cognitive psychology—how does the mind develop; developed brilliant methods of observation and experimentation; and put forth a convincing picture of development—a set of general cognitive operations that unfold in the course of essentially lockstep, universally occurring stages. I wrote my first books about Piaget; saw myself as carrying on the Piagetian tradition in my own studies of artistic and symbolic development (two areas that he had not focused on); and even defended Piaget vigorously in print against those who would critique his approach and claims.
>
> Yet, now forty years later, I have come to realize that the bulk of my scholarly career has been a critique of the principal claims that Piaget put forth. As to the specifics of how I changed my mind:
>
> Piaget believed in general stages of development that cut across contents (space, time, number); I now believe that each area of content has its own rules and operations and I am dubious about the existence of general stages and structures.
>
> Piaget believed that intelligence was a single general capacity that developed pretty much in the same way across individuals: I now believe that humans possess a number of relatively independent intelligences and these can function and interact in idiosyncratic ways …
>
> … Finally, Piaget saw language and other symbols systems (graphic, musical, bodily etc) as manifestations, almost epiphenomena, of a single cognitive motor; I see each of these systems as having its own origins and being heavily colored by the particular uses to which a system is put in one's own culture and one's own time.

> Why I changed my mind is an issue principally of biography: some of the change has to do with my own choices (I worked for 20 years with brain damaged patients); and some with the Zeitgeist (I was strongly influenced by the ideas of Noam Chomsky and Jerry Fodor, on the one hand, and by empirical discoveries in psychology and biology on the other). (Gardner, 2008)

Vygotsky

Lev Semyonovich Vygotsky (1896–1934), a Russian psychologist, is the scholar who is most prominently associated with constructivism today. He proposed a theory of cognitive development that emphasized the underlying process rather than the ultimate stage of human development and he focused on the social rather than individual context of human cognitive development. Vygotsky's view of constructivism was a reaction against that of Piaget. Vygotsky focused on the relationship between the cognitive process and a subject's social activities. Whereas Piaget focused on what is biological human development, i.e., individual development, Vygotsky emphasized the social context of human development and learning. Piaget placed the developmental stage before learning, whereas Vygotsky placed learning before development. Piaget emphasized biological development (the theory of stages); learning, for Vygotsky, preceded and led to development.

Vygotsky's theories are most famously presented in his book *Thought and Language* (1962), written shortly before his early death. The title of the book illuminates Vygotsky's position that thought and language are integral to one another. Vygotsky argued that humans, even as infants, engage in internal dialogue, and it is the internalization of this dialogue that leads to speech and thought. All humans are taught language by those who speak to the child, point at and name things and introduce language to make meaning of the child's experiences. Jerome Bruner, the American psychologist who brought Vygotsky to the notice of American educators, notes that Vygotsky used the epigraph "*Natura parendo vincitur*" ("we must understand and obey the nature of the human being").

> For it is the internalization of overt action that makes thought, and particularly the internationalization of external dialogue that brings the powerful tool of language to bear on the stream of thought. Man, if you will, is shaped by the tools and instruments that he comes to use, and neither the mind nor the hand alone can amount to much. … And if neither hand nor intellect alone prevails, the tools and aids that do are the developing streams of internalized language and conceptual thought that sometimes run parallel and sometimes merge, each affecting the other. (Bruner, 1962, vi–vii)

Vygotsky's approach to human development was fundamentally different from that of other developmental psychologists. Rather than focusing on a particular period of development, most commonly how a child becomes an adult, Vygotsky posed research questions with a broader perspective: What is the process of intellectual development from birth to death?

Vygotsky studied the processes of how a child developed, rather than how well the child performed: What did the child do under various task conditions and how did the child respond to the task? Vygotsky also considered the importance of tool invention and use as a prerequisite but not sufficient condition for the evolution of cognitive functioning. What was of key importance for Vygotsky was the role of social and cultural factors: biological development does not occur in isolation. Thus, the basic human condition is based on social use of tools. The development of culture was the internalization of the tools of the culture. Vygotsky offered a socio-historical perspective: tools emerge and change, as do cultures. Tools are part of our cultural and cognitive development.

Social interactions are an essential part of human cognitive development, Vygotsky argued. Thus, while other animals may also use tools, humans went beyond that to develop social speech.

Whereas other theories of human development focused on the individual, Vygotsky focused on social activity. Rather than viewing development as the progress from the individual into social relations, Vygotsky posited the opposite: he viewed socialization as leading to higher (individual) cognitive functions. Moreover, the process of conversion from social relations to psychological function is mediated by some kind of link or tools. A tool is something that extends our abilities in the service of something else, while a sign signifies something else.

Human speech is a key example: Vygotsky emphasized both egocentric speech and social speech. He wrote that whereas Piaget viewed egocentric speech as reflecting egocentric thought and reasoning in a preoperational child, a pattern which then disappears as the logical operations of the next stage are acquired, Vygotsky himself believed that egocentric speech evolves into inner speech. It does not disappear, but "denotes a developing abstraction from sound, the child's new faculty to 'think words' instead of pronouncing them" (Vygotsky, 1962, p. 135). All known facts of egocentric speech, writes Vygotsky, point to one thing: "It develops in the direction of inner speech … egocentric speech is not yet separated from social speech" (1962, pp. 135–136). Based on his experiments, Vygotsky concluded that as children become more aware of themselves as individuals within a social world, their egocentric speech becomes subvocal and inner-directed. Egocentric speech leads to inner-directed thought; thought then leads to social speech.

Vygotsky's theory of intellectual development is also a theory of learning; he studied the behavior of young children where there is a "prelinguistic phase in the use of thought and a pre-intellectual phase in the use of speech" (Bruner, 1962, vii).

The title of Vygotsky's 1962 book was translated from Russian as "*Thought and Language*." It could also be translated as "thinking and speaking." Thought and speech are highly interrelated in Vygotsky's theory.

Vygotsky's theory of learning emphasizes the role of social and cultural influences on our thoughts and language. Vygotsky created the concept of ZPD, the "zone of proximal development" (proximal is a term meaning nearest). According to ZPD, learning takes place when learners solve problems beyond their actual developmental level—but within their level of potential development—under adult guidance or in collaboration with more capable peers. What this means is guided or supported learning. This does not suggest that the instructor guides the learner to the

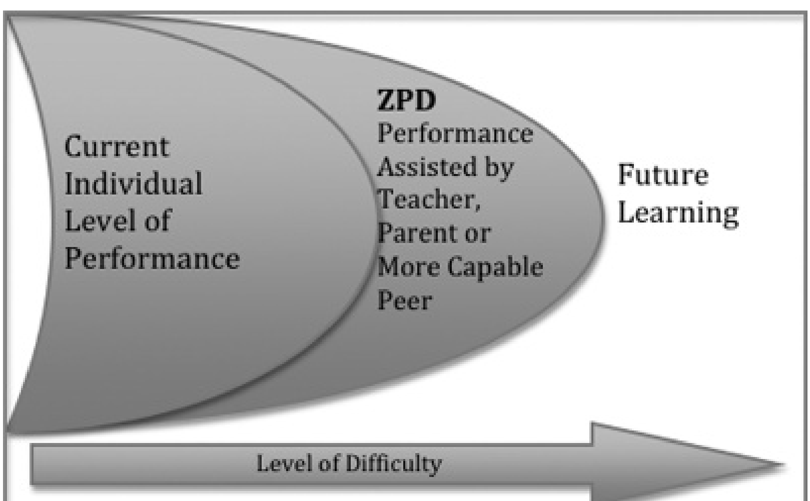


Figure 5.2 Zone of Proximal Development.

instructor's intended goal through successive approximations (as in Skinner's behaviorism) but, on the contrary, that the more advanced peer or teacher (or parent) supports the learner by providing the tools (language, concepts) needed to advance, and eventually independently achieve the learner's intended goal.

Although Vygotsky never used the term scaffolding as a metaphor, it has become closely associated with ZPD, in which the peer or adult supports the learner in constructing knowledge. Scaffolds in learning can be compared with the use of scaffolds in the construction of buildings.

> The scaffold, as it is known in building construction, has five characteristics: It provides a support; it functions as a tool; it extends the range of the worker; it allows the worker to accomplish a task not otherwise possible; and it is used selectively to aid the worker where needed … a scaffold would not be used, for example, when a carpenter is working five feet from the ground. (Greenfield, 1984, p. 118)

In the classroom, a scaffold is a set of activities designed by the teacher to assist the learner in moving through increasingly difficult tasks to master a new skill. The teacher designs the classroom activities based on the student's prior knowledge; that is, for example, what they learned previously in the classroom or perhaps through other life experiences. Classroom activities are designed to help move students from point A to point B, to progress from what they know to what they need to know to complete the course or the class unit—to bring them through the zone of proximal development to achieve their potential.

Constructivist Learning Pedagogy

How we perceive knowledge and the process of "coming to know" shapes our educational practice. If we believe that learners passively receive information, then priority in instruction will be on transmission of knowledge to the learner. If, on the other hand, we believe that learners actively construct knowledge in their attempts to make sense of their world, then instruction is likely to emphasize the development of meaning and understanding.

Constructivist pedagogies focus on the learner or group of learners, while pedagogies associated with behaviorist and cognitivist theories focus on the instructional designer or instructor rather than the learner in the organization of learning. Constructivist learning theory focuses on the role of the learner in making meaning and constructing understanding. Both Piaget and Vygotsky emphasized the active role of the learner, but whereas Piaget emphasized stages of behavior and the child's accomplishment according to preceding developmental stages, Vygotsky emphasized the importance of social interaction. Children, according to Vygotsky, build new concepts by interacting with others and receiving feedback on their hypotheses or the task that they are seeking to accomplish. This is the zone of proximal development, in which a child discusses a problem, a task or a concept with an adult or competent peer who can assist the child by providing the language needed to solve the problem or accomplish the task. The child internalizes the language until she or he is able to complete the task independently.

The constructivist view of learning has generated a number of teaching approaches based on the following four key principles or values:

1. active learning;
2. learning-by-doing;
3. scaffolded learning;
4. collaborative learning.

Active Learning

In the most general sense, active learning means encouraging students to participate and act, such as conducting a real experiment, rather than learn passively (listening to a lecture, reading a book). Active learning is typically student-centered, and the role of the student is to engage in an activity, such as constructing and testing a theory, hypothesis or strategy. Students then reflect on and discuss what they are doing and how their understanding is changing. The teacher must understand the students' pre-existing conceptions and guide the activity to address, build on and refine pre-existing conceptions.

Contrary to criticisms by some educators, constructivism does not dismiss the active role of the teacher or the value of a parent or a knowledge expert. Rather than transmit information or knowledge to the student, however, the constructivist teacher encourages and assists students in constructing their knowledge about a subject rather than reproducing a series of facts about it. The constructivist teacher introduces techniques such as problem-solving and inquiry-based learning activities whereby students formulate and test their ideas, and draw conclusions and inferences. They may do this individually or pool and convey their knowledge in a collaborative learning environment. The learner is viewed as an active participant in the learning process. Guided by the teacher, students actively construct their knowledge rather than mechanically ingest knowledge from the teacher or the textbook. The teacher thus plays an active and essential role, assisting in identifying a knowledge problem, providing guidance in how to understand it and suggesting resources. The problem (or question) should be interesting, relevant, appropriate and engaging to the learner, so that the student feels that it is her or his knowledge problem. In addition, the problem should be what educators refer to as "ill-defined" or "ill-structured," meaning that it is not just an easy problem, but one that is like problems in the real world. It should be complex. And authentic, in that it reflects what practitioners do. Authentic activities focus on active learning in real-world contexts, and typically involve production, rather than activities that are abstract or remote from practice.

Constructivism seeks to tap into and trigger the student's innate curiosity about the world and how things work. Students are not expected to reinvent the wheel but to attempt to understand how it turns, how it functions. They are engaged by applying their existing knowledge and real-world experience to the problem, learning to hypothesize, test their theories and ultimately draw conclusions from their findings.

Pedagogies designed in the tradition of active and authentic learning problems may involve individual or collaborative approaches. Bodner, a professor of chemistry, writes about the role of the constructivist teacher in shifting from someone who teaches to someone who *facilitates* learning, teaching by *negotiation* rather than imposition (1986). Bodner notes that social knowledge such as the days of the week or symbols for chemical elements can be taught by rote or direct instruction. And probably should be. "But physical and logico-mathematical knowledge cannot be transferred intact from the mind of the teacher to the mind of the learner" (Bodner, 1986, p. 876). This kind of knowledge benefits from active constructivist learning. Bodner describes a constructivist dialogue between a professor and his students:

> This dialog shows many of the signs of a constructivist teacher who questions students' answers whether they are right or wrong, insists that students explain their answers, focuses the students' attention on the language they are using, does not allow the students to use words or equations without explaining them, and encourages the student to reflect on his or her knowledge, which is an essential part of the learning process. (1986, p. 876)

Learning-by-doing

In *Time* magazine's 1999 special issue on "The Century's Greatest Minds," Seymour Papert cites Albert Einstein as using the words "so simple only a genius could have thought about it" to describe the theory advanced by Piaget that children don't think like adults (Papert, 1999, p. 105). Papert writes that Piaget

> is revered by generations of teachers inspired by the belief that children are not empty vessels to be filled with knowledge (as traditional pedagogical theory has it), but active builders of knowledge—little scientists who are constantly creating and testing their own theories of the world. (1999, p. 105)

Papert notes that

> Piaget was not an educator and never enunciated rules about how to intervene … But his work strongly suggests that the automatic reaction of putting the child right may well be abusive. Practicing the art of making theories may be more valuable for children. (ibid.)

Seymour Papert (1928–2016) was a co-founder, with Marvin Minsky, of the Artificial Intelligence Laboratory at Massachusetts Institute of Technology (MIT) and a founding faculty member of the MIT Media Laboratory. Papert collaborated with Piaget at the University of Geneva in the late 1950s and early 1960s. He created the Logo computer programming language used as an educational tool for children. In 1981, he founded Logo Computer Systems Inc. (LCSI) as a publisher of constructivist educational software for K–12 schools around the world. The LCSI website states that: "The constructivist philosophy believes that students excel by building and constructing for themselves the specific knowledge that they need rather than having a teacher dictate numerous facts. Teachers play a role as knowledge facilitators" (Logo Computer Systems Inc., 2002).

Papert is well-known for developing the Logo programming language and applying it in education based on constructivist pedagogy. However, Papert writes, there is more to it than that: what is important is not the programming language but a certain spirit, a "Logo spirit." This spirit or philosophy is based on "doing something," "getting something done." Papert adapted the term "constructivist" to "constructionist," to signify a philosophy of life, a philosophy of learning by doing and especially learning by making.

> The frame of mind behind the Logo culture's attitude to "getting it to happen" is much more than an "educational" or "pedagogic" principle. It is better described as reflecting a "philosophy of life" than a "philosophy of education." But insofar as it can be seen as an aspect of education, it is about something far more specific than constructivism in the usual sense of the word. The principle of getting things done, of making things—and of making them work—is important enough, and different enough from any prevalent ideas about education, that it really needs another name. To cover it and a number of related principles (some of which will be mentioned below) I have adapted the word constructionism to refer to everything that has to do with making things and especially to do with learning by making, an idea that includes but goes far beyond the idea of learning by doing. (Papert, 1999)

Papert writes that education has two wings: one is informational, while the other is constructional. Public perception of technology in general, and educational technology in particular, is a distortion, a one-sidedness that emphasizes the informational and ignores the constructional. It is a one-sidedness that also characterizes public views of education, which emphasize the informational over its constructional role.

> There's education as putting out information; teacher lecturing, reading the book. There's learning by doing, which is the constructional side versus the informational side. And, unfortunately, in our schools the informational side is the one that gets the emphasis, and so there's this line-up between one-sided emphasis in the thinking about school, and the one-sided emphasis in thinking about technology. Both of them emphasizing the informational side, and they reinforce one another. So in many ways, through this, the wrong image we have of what digital technology is about reinforces instead of undermining some of the weaknesses and narrowness of traditional education. (Papert, quoted in Schwartz, 1999)

Papert's constructionism describes an educational philosophy that teaches children to *do* something rather than teaching them *about* something. Some of his early work involved teaching children to be mathematicians rather than teaching them about mathematics in the traditional way.

This led to the Logo language, which is a form of LISP programming language. The Logo language was developed in conjunction with a device called a turtle, which was a small robot holding a pen which could be programmed to draw geometric shapes.

Other constructivist pedagogical approaches include the following:

- *Problem-based learning* (PBL) is the use of a convincing scenario based on a realistic problem presented to a student. Various aspects of the problem may be presented from different perspectives.
- *Distributed problem-based learning* brings together a group of learners working together to solve a problem.
- *Case-based learning* engages students in discussion of specific situations, typically real-world examples. This method is learner-centered and involves group engagement in knowledge-building and analysis of the case. Much case-based learning involves learners striving to resolve questions that have no single correct answer; this approach is widely used in such disciplines as medicine, business and education.
- *Inquiry-based learning* is a form of self-directed learning. Students take more responsibility for: determining what they need to know; identifying the appropriate resources; using the resources in their learning; assessing and reporting their learning.
- *Role-play simulation* and *game-based learning*: these are learning processes in which participants act out the roles of specific individuals or organizations in order to develop particular skills and/or to assume different perspectives in order to gain a deeper appreciation of the problem being addressed. A simulation or a game involves an artificial environment or plausible scenario that supports the roles, processes and structures of active and authentic learning.

Scaffolded Learning

Vygotsky created the concept of the zone of proximal development (ZPD) which, as noted earlier in this chapter, has also come to be known as scaffolding. With ZPD or scaffolding a more knowledgeable peer or adult supports the learner in constructing knowledge, until the learner no longer needs this support. Scaffolding refers to specialized teaching strategies or tools designed to support learning when students are first introduced to a new subject. Scaffolding gives students a context, motivation and foundation from which to understand the new information. In order for learning to progress, scaffolds should be gradually removed as the learner progresses, so that students will eventually be able to demonstrate comprehension independently. The premise is that scaffolding is not instruction but a form of collaboration between the teacher and the learner as part of the process of learning, something that the learner could not previously conduct on his or her own but is now able to achieve independently. As noted earlier, the term scaffolding derives from the tools that support the construction of buildings. It also refers to the activities of a teacher or mentor or parent to support the child in progressing from his or her actual level of development to achieving the potential level of development.

Collaboration

A key principle of social constructivism is the pedagogical emphasis on the role of "collaboration," particularly among the learners, but it can also include collaboration between children and adults, such as teachers, parents or practitioners. Unlike "cooperative learning," in which each group member contributes an independent piece to the whole as a division of labor, in collaborative learning the members participate and interact throughout the process to co-produce a finished artifact or product. However, collaboration does not guarantee the use of constructivist approaches.

> The use of groups may simply be used as an alternative instructional strategy, with little change in the learning goals from traditional didactic instruction … From this perspective, groups are used for reasons that include providing variation in the classroom activity, teaching students how to cooperate and work together, sharing work loads and hence permitting larger projects, and to promote peer tutoring. (Duffy & Cunningham, 1996, pp. 186–187)

Constructivist collaboration, on the other hand, argue Duffy and Cunningham, emphasizes the sharing of alternative viewpoints and challenging or developing each alternative point of view. "Hence, our reason for using groups is to promote the dialogical interchange and reflexivity" (Duffy & Cunningham, 1996, p. 187).

Typically, collaboration refers to a small group (of perhaps 3–5 students) for a team project or up to 20 students in a group discussion, debate or seminar. Students work together to discuss the topic or to conduct the project.

Collaborative approaches such as scaffolding or cognitive apprenticeship are most often based on interaction between the learner and the teacher. As noted above in the discussion of scaffolding, the support of the teacher is slowly taken away as the learner gains proficiency and learns the topic and becomes able to independently understand and use the concept or tool. This is also the case with ZPD, in which the learner is able to achieve his or her potential through the support of a more knowledgeable other or a teacher.

Lave and Wenger (1991) point to the importance of society's practical knowledge and the learning that goes on among practitioners in communities of practice. Other social constructivist pedagogical approaches include peer collaboration, learning networks or communities: methods that involve group interaction and learning with others.

Constructivist pedagogies have developed outside the learning theories developed by Piaget or Vygotsky. Neither Piaget nor Vygotsky were linked to education during their lifetimes. Piaget was devoted to a tremendous range of interests, but these did not include educational practice. Vygotsky died at a very early age. Educators have nonetheless actively engaged with the notions of constructivist learning, albeit with little theoretical guidance. Concepts of social democracy stemming from the 1970s have strongly influenced education. Hence there has been a strong focus on principles such as active learning, learning by doing and collaboration, but without theoretical clarity on how these techniques contribute to learning and hence how to implement them. The role of the teacher has been unsettled. As noted earlier in this chapter, Papert wrote that: "Piaget was not an educator and never enunciated rules about how to intervene … But his work strongly suggests that the automatic reaction of putting the child right may well be abusive" (1999, p. 105). Hence, the teacher should not correct the student. Moreover, the teacher should be a participant in the classroom, as Logo Computer Systems, Inc. (2002) notes: "We believe that there is such a thing as becoming a good learner and therefore that teachers should do a lot of learning in the presence of the children and in collaboration with them." Popular slogans have emphasized that the role of the constructivist teacher is as "guide on the side" not "sage on the stage." The role of the teacher has been marked by the reactions against instruction, yet without clear alternatives.

Constructivist Learning Technology

The technologies specifically associated with constructivist learning were often referred to as learning environments or microworlds. The term learning environment was primarily associated with computer-based software that is open-ended to enable and require user input, action and agency, rather than online or web-based environments.

David Jonassen (1994, p. 35) summarized several characteristics as distinguishing constructivist learning environments, such as:

1. provide multiple representations of reality, to avoid oversimplification;
2. "represent the natural complexity of the real world";
3. emphasize knowledge construction instead of knowledge reproduction;
4. emphasize authentic tasks in a meaningful context rather than abstract instruction out of context;
5. provide learning environments such as real-world settings or case-based learning instead of predetermined sequences of instruction;
6. foster thoughtful reflection on experience;
7. "enable context- and content-dependent knowledge construction";
8. support "collaborative construction of knowledge through social negotiation," not competition among learners for recognition.

Jonassen's list has been accepted by both social and cognitivist constructivists, albeit with some differences in emphasis.

Computers are viewed as the optimal medium for applying constructivist principles to educational practice, because computer software can support various strategies and approaches more easily and effectively than other media. Computer software can also link to the resources necessary in simulations and microworlds. Computer-based constructivist learning environments such as construction kits, microworlds, scaffolded intentional learning environments, learning networks (telecollaboration) and computer-supported collaborative learning environments were developed in the 1980s and 1990s, and are discussed below.

Construction Kits and Microworlds

In the late 1980s and 1990s educational computer software development sought to support the variety of ways learners construct their own understanding—both as independent work and in collaboration with other learners. Microworlds were designed to provide students with opportunities to connect prior learning with current experience, and they were often created by learners using computer tools as construction kits.

Papert was an early contributor to computing and the educational world. In fact, he writes that in the 1960s people laughed at him when he talked about children using computers as instruments for learning and for enhancing creativity: the idea of an inexpensive personal computer seemed like science fiction at the time (www.papert.org). But, he notes, it was in his MIT laboratory that children first had the chance to use the computer to write and to make graphics. The Logo programming language was created there, as were the first children's toys with built-in computation. Logo could be used by students of various ages and computer experience to construct and engage in microworlds.

Logo enabled young learners to experiment in a geometry microworld, creating or constructing objects such as houses, buildings and cities. Logo also enabled students to create objects with motors controlled by the computer, similar to Papert's original turtle robot. Today Logo is linked with the Lego Company, and involves robotics for school children.

Papert viewed programming as key to the constructivist culture. He acknowledges that Logo may not be the solution, but argues that it expresses the liberation of learning from pre-digital learning technologies.

> The Logo programming language is far from all there is to it and in principle we could imagine using a different language, but programming itself is a key element of this culture …
>
> But one can be sure that an alternative culture of educational programming will not emerge soon, or ever … This claim is not based on an arrogant belief that we the inventors of the Logo philosophy are smarter than everyone else. It is based on the belief that the Logo philosophy was not invented at all, but is the expression of the liberation of learning from the artificial constraints of pre-digital knowledge technologies. (Papert, 1999, p. xvi)

Another early contribution to constructivist learning technologies was Apple Computer's HyperCard software. HyperCard was a multimedia database that enabled users to create linkages among multiple objects on a personal computer. Learners used HyperCard to construct presentations on different subjects, selecting and linking a wide range of resources to organize and display information, reports, projects and presentations. One simple example was a classroom postcard project: each student created a HyperCard postcard comprising a message and a graphic. Postcards were bundled and sent as a file online by a teacher in one school to a project classroom elsewhere—where students would read the postcards and respond. In the late 1980s the ability to link graphics with text was a major technological advance, a limited skill among teachers and students.

Mind tools refers to computer tools intended to serve as extensions of the mind. Examples of mind tools are databases, spreadsheets, emails or concept maps. Jonassen created a software called Mindtools as "a way of using a computer application program to engage learners in constructive, higher-order, critical thinking about the subjects they are studying" (Jonassen, 1996). The learner enters an intellectual partnership with the computer to access and interpret information and organize personal knowledge in new ways, using a database or spreadsheet tool.

Scaffolded Intentional Learning Environments

Computer-based constructivist learning environments were developed during the 1980s and 1990s, and some of these went online using local area networks, mainframe computers or the internet. CSILE (computer-supported intentional learning environment) was developed by Carl Bereiter and Marlene Scardamalia in 1983, initially at York University, Toronto, and then at the Ontario Institute for Studies in Education, University of Toronto. Scardamalia, Bereiter, McLean, Swallow, & Woodruff (1989) wrote:

> There has been a history of attempts in computer-assisted instruction to give students more autonomy or more control over the course of instruction. Usually these attempts presupposed a well-developed repertoire of learning strategies, skills, and goals, without providing means to foster them. (p. 51)

Scardamalia and Bereiter envisioned an environment in which students could learn and practice these metacognitive skills. Their CSILE software aimed to foster rather than presuppose a student's metacognitive abilities. It was designed to scaffold knowledge-building activities, using a communal database constructed by learners and their teachers. Students would enter text and/or graphic notes into the database on any topic created by the teacher. All students in the project read one another's notes and could contribute to or comment on them, using computers linked together on a local area network. Authors would be notified when comments were made. In 1983, CSILE was prototyped in a university course and in 1986 it was used for the first time in an elementary school, as a full version. In 1995, the software was redesigned in accordance with the internet and renamed Knowledge Forum (discussed in Chapter 6).

Learning Networks or Telecollaboration

Another category of constructivist learning environments in the 1980s and 1990s is referred to as telecollaboration or online learning networks (Harasim et al., 1995). Learning network projects began with the use of email running on mainframe computers. The development of the internet led to a vast number of class–class or school–school network learning activities. One of the earliest examples of online learning networks or telecollaboration was the work by Margaret Riel who created the pedagogical approach of Learning Circles. Learning Circles were student-centered learning projects that began as cross-classroom projects, in which classrooms in different schools and countries communicated by email; by the 1990s, the AT&T telecommunications corporation and then the National Geographic Society offered learners and teachers the opportunity to work with leading scientists. Students also had access to online curriculum units in the sciences in which they collected data and ran and shared their results with others in the network. Riel continues to design, research and direct Learning Circles, a program that brings student/teacher teams from different counties into project-based learning communities over electronic networks. The Learning Circle network is now part of the International Education and Resource Network (iEARN). Riel also helped design the model for Passport to Knowledge, a National Science Foundation funded "electronic travel" socio-technical network.

Another telecollaboration model is the JASON project founded in 1989 by Robert D. Ballard following his discovery of the shipwreck of the *RMS Titanic*. Given the huge interest in this discovery expressed by children, Ballard and his team dedicated themselves to developing ways to enable teachers and students around the world to participate in global explorations using interactive telecommunications such as email. Since then, JASON has connected more than ten million students and teachers with real scientific exploration and discovery. Participants engage in community-based partnerships related to scientific exploration and analyses. Teacher professional development programs are also included. For example, "Operation: Resilient Planet" is an ecology curriculum unit based on National Science Education Standards including Science as Inquiry, Physical Science, Life Science, Earth and Space Science, Science in Personal and Social Perspectives and History and Nature of Science. The complete curriculum includes print, video, online games, online labs and fieldwork based on an interactive website, the JASON Mission Center, where students from across the globe can put their knowledge to work and take the Argonaut Challenge. The JASON Foundation for Education was founded in 1990 as a nonprofit organization to administer the project. The Foundation became a subsidiary of the National Geographic Society in 2005.

MayaQuest is a similar project that enables students to follow and connect with a team of scientists trekking by bicycle through the jungle to remote archeological sites. Students ask questions of the scientists and of the local people, and engage in scientific activities using the internet.

The online learning environment provides access to social/contextual support. Computers are used to assist active experiences—gathering data and resources, conversing with colleagues, struggling through a challenging puzzle or application—or to aid reflection. For example, while an online conversation through email is an active event, such discussions usually prompt reflection. Teachers can also employ computers as authoring tools for such pedagogies as students' journals and portfolios, to encourage learner examination of experience.

The use of real-world tools, relevant experiences and meaningful data seeks to inject a sense of purpose to classroom activity. Students learn, among other things, to manipulate and analyze raw data, critically evaluate information and operate hardware and software. This technological literacy imparts a very important set of intellectual and technical skills intended to serve students well in the working world.

The depth and breadth of online information poses its own challenges, however. Internet content is less structured and manageable than material outlined by a textbook. Information from the internet is more dynamic than the printed word. Students need to learn to question and evaluate the information they find. There are many internet sites that offer raw data—pictures from space, numbers from the census and text from court testimony. These resources need context to provide meaning, and lessons should include components that help students use the information wisely and productively, bearing in mind the need to always ascertain the currency and authenticity of the data.

Online Learning and Course Delivery Platforms

The need for online platforms to support the delivery of online courses or educational activities became recognized and in the 1990s a variety of software began to emerge to address this important issue. These platforms were known under various names such as learning management systems, course management tools, virtual learning environments and computer-supported collaborative learning software. Generally, they were not especially customized to scaffold particular learning strategies. In the 1980s, the field of online education was primarily based on the use of computer conferencing (and in some cases, email). In the late 1990s "learning" platforms had evolved into more sophisticated conferencing or forum systems, quiz tools, gradebooks and other administrative tools. Together, these generic tools could be accessed by the teacher and the learner to support educational projects or courses. Examples of asynchronous learning platforms in the 1990s and 2000s include Blackboard, WebCT, Desire2Learn and Moodle.

Online learning platforms or environments are constructivist in that they facilitate user-generated content; they can be structured by the user (teacher or learner) to support online discussion, discourse and work projects. The environments most used today are generic asynchronous discussion forums with additional tools. The discussion forum can be structured to support subforums (such as seminars with related role plays or small-group discussions), to open or close forums at specific times or dates, to facilitate specific pedagogical activities (a lecture, a podcast, a question-and-answer forum) and other forms of discourse. However, many educators typically use only one or two online tools and ignore the discussion forum software. For example, teachers may use only the quiz tool and perhaps the gradebook; or only post the course material online, for students to download. The examples of online quizzes, gradebooks, podcasts or posting of course materials do not engage the learner in constructivist interactions such as discussions, debates or other knowledge-building interactions. Unfortunately, developers of constructivist learning environments could not ensure that teachers would use constructivist pedagogies when using their technologies. As Driscoll notes, the developer of the constructivist computer conferencing software, Construe, acknowledged that the software could also be "used to support very traditional instructional strategies" (2005, p. 406). Nevertheless, Driscoll disagrees. She writes:

> However, as one who has herself employed Construe in a graduate course, I am convinced that the use of all the software's features as an integrated system guarantees a very powerful learning environment that will yield learning outcomes consistent with constructivism. (2005, p. 406)

The word "guarantees" is probably over-optimistic. The availability of constructivist features does not compel their effective use or their use at all. The lack of educational frameworks and guidelines has held back progress in this area, because teachers do not understand the underlying pedagogies or theory, may not know how to use the various features or do not choose to use them in their classroom or online courses.

Nonetheless, many tools and platforms developed in the 1990s are maturing in the sense of incorporating scaffolds, new pedagogical supports and other features to more explicitly facilitate knowledge building and collaborative learning. Research, field experience and, in the case of open source software, new environments are emerging to address improvements in the field of online learning and knowledge building. These are discussed in Chapter 6.

Summary

Chapter 5 focused on constructivist learning theory, constructivist pedagogy and associated technologies. As we have seen, there has been an evolution in the nature and focus of learning theories in the 20th century. Behaviorism emphasized stimulus–response, and the need to tightly control the learning through pedagogies and technologies associated with instructional design. Cognitivist learning theory was a reaction to, but also, in certain ways, an extension of, behaviorism. Cognitivism rejected the closed black box metaphor of behaviorism and focused instead on what was in the black box, seeking to understand what happens in the mind between the stimulus and response or inputs and outputs. In cognitivism, the mind is primarily represented by computational metaphors such as a cognitive information processing unit or mind as computer. The mind of a student, for example, acquires information sent by a knowledge transmitter, the teacher. The pedagogies and technologies associated with cognitivism emphasize the ability to transfer or transmit the message accurately and efficiently.

Constructivism introduced a new perspective to 20th-century learning theory, both in terms of theory and of epistemology. It offered a perspective that views knowledge as constructed by the learner, either through physical development and maturation as posited by Piaget, or primarily influenced by the socio-cultural context, as theorized by Vygotsky, whereby the mind generates thought, language and knowledge.

Constructivism resonated with practicing teachers and became a highly popular concept in the field. However, neither Piaget nor Vygotsky had ever written about the implications of their theories for the classroom, and hence the resulting constructivist pedagogies and technologies were primarily attempts by practitioners to implement notions of active learning. Constructivist pedagogies were characterized by such broad principles as active learning, learning-by-doing or learning-by-making, scaffolded learning and collaboration. Constructivism also stimulated the development of a variety of technologies and their application. The use of the computer, and eventually computers linked by local area networks and then the internet, was a powerful catalyst that contributed significantly to the rise of online learning networks and similar applications.

The advance of online technologies in education has, however, rapidly progressed with theories, pedagogies and technologies based on both objectivist and constructivist epistemologies. Commercial investment in learning technologies and pedagogies has led to developments such as MOOCs (massive open online learning), PLEs (personalized learning environments) and ALS (adaptive learning systems), which emphasize individualized, network or AI-managed learning. Chapter 6 introduces connectivism which promotes network-organized learning.

6
Connectivism as an Online Learning Theory

> Google: Answers before you ask.
>
> **—Google advertising slogan 2014–2015**

Chapter 6 presents the following topics:

- Context of connectivism and online learning networks
- Connectivism as an online learning theory and major thinkers
  - Siemens
  - Downes
  - Comments and critiques
- Connectivist learning pedagogy:
  - MOOCs
  - cMOOCs and xMOOCs
- Connectivist learning technologies:
  - Computer networks
  - Artificial intelligence and machine learning.

Context of Connectivism and Learning Networks

The invention of computer networking in 1969, and of email and computer conferencing in the early 1970s, introduced new and unprecedented possibilities for human communication and education. By the mid-1970s, a few professors involved in computer networking research began to explore educational applications for networking in their own classrooms (Hiltz and Turoff, 1978). By the early 1980s, school-based learning networks emerged, experimenting with online collaboration through such projects as electronic pen pals, online newsletters, online field science activities and cross-cultural exchanges with schools in other countries (Harasim, 1990b; Harasim et al., 1995). In 1986, the first totally online credit university course was delivered at the Graduate School of Education, University of Toronto (Harasim & Smith, 1986; Harasim & Smith, 1994).

The adoption of online courses and learning networks spread during the 1980s. The decade was characterized by educational activities that emphasized online collaboration and distributed team projects at both university and school levels. As the field grew in the early 1990s, organizations involved in distance education began exploring online networks for course delivery, some adopting the collaborative learning pedagogy that will be discussed in the upcoming chapters, while others continued a correspondence model with tutors. By the late 1990s, training organizations also began to adopt online delivery, using the internet to post self-paced, computerized courseware programs that replaced trainers and tutors. Participants could access courseware, also known as elearning, directly online.

This chapter, and those that follow, introduce two distinct views of learning associated with online learning networks. Both have received significant academic and/or media attention in recent years. This chapter presents the concept of connectivist learning which was first presented as a theory in 2004; it introduces and examines connectivism as a new learning theory. Chapter 7 will present and explore collaborativist learning theory (aka OCL), developed over three decades of practice, field research and observation.

These two concepts of online learning, connectivism and collaborativism, reflect two different and distinct approaches to theory building. Connectivism represents a deductive approach in which a hypothesis is first posed as an idea which is then tested through data collection. This is informally called a "top-down" approach, in which supporting evidence follows. Deductive reasoning works from the more general (theory) to the more specific (its applications), and seeks evidence to either confirm or refute the hypothesis.

George Siemens proposed connectivism as the theory of learning for the digital age in a post to his blog, *elearnspace.org*, in 2004 (Siemens, 2004). Stephen Downes, a co-founder of connectivism, supported the theory in a 2005 post to his blog, OLDaily (Downes, 2005).

Connectivism, examined in this chapter, was initially based on a concept of self-organized learning but evolved over time into an emphasis on network-organized learning: the idea being that a networked environment without instructors and course structure can facilitate and achieve learning among participants. From the connectivist perspective, learning is based on the notion of network intelligence, in which the computer network (not a human teacher or peer) identifies and organizes the links for each learner. Connectivism was pronounced a theory by its proponents but, as discussed in this chapter, after more than a decade the theory has not been empirically confirmed by its founders or by others.

Typically, deductive processes include clinical or controlled studies in which a *theory* about a particular topic is presented, then narrowed into a more specific *hypothesis* that can be tested. *Observations*, in the deductive approach, are then collected to test the hypothesis with specific data—to *confirm* or refute the original theory. Deductive reasoning is represented in the flowchart below. While it is an acceptable academic approach, it requires follow-up with supporting evidence to confirm or negate the theory.

Theory → Hypothesis → Testing → Evidence → Confirmation (or not)

The second learning theory related to the digital age, collaborativism (aka online collaborative learning or OCL), presented in Chapter 7, reflects inductive reasoning. Inductive reasoning takes the opposite approach. It is based on the existence of significant practical experience and evidence which is then analyzed and filtered to become the basis of a theory. Inductive research moves from specific observations to broader generalizations and theories. Informally, this is called a "bottom up" approach. In inductive reasoning, we begin with specific observations and measures which, through ongoing data collection and data analysis, demonstrate patterns and regularities that can become generalized conclusions and theories. *Learning* theory typically arises from field research and observation, rather than deductive proclamation. In Chapter 7, the theory of online collaborative learning is presented as based on over 30 years of research and practice. The process is represented in the flowchart below.

Observation of practice → Patterns discerned → Conclusions → Theory

The evolution of OCL practice is an example of inductive reasoning in practice. The articulation of OCL theory emerged through three decades of practice and research. OCL, in various forms and applications, has been the primary educational approach to learning networks since the early 1980s (Mason and Kaye, 1989; Harasim, 1990a, 1990b; Hiltz, 1994; Harasim et al., 1995; Bates, 2015b). Thus, the pedagogy has received a broad understanding and acceptance throughout the learning community and, as such, is a fitting focus for the final chapters of this book.

Chapter 6 begins by examining whether connectivism meets the criteria of a theory. We look at its history, context and definitions. Section two of the chapter provides a more thorough exploration of connectivist learning as a theory and a discussion of the key figures associated with it: the founders, George Siemens and Stephen Downes, as well as inputs by associates and researchers.

Section three focuses on the pedagogy of connectivist learning, specifically examining the massive open online courses known as MOOCs. We examine the invention of the MOOC as a term and as an educational activity with the first MOOC course taught by George Siemens and Stephen Downes in 2008 at the University of Manitoba. This was the first experiment of connectivism in practice and an instantiation of connectivist pedagogy. In 2011, the use of the term "MOOC" in online Stanford University computer science courses taught by professors Sebastian Thrun, Peter Norvig, Andrew Ng and Daphne Koller triggered a MOOC "media madness" that, among other things, promoted the assumption that the MOOC was an American invention. The intense media attention, moreover, sparked public and professional discussion on the nature of online post-secondary education and intensified for-profit ventures in education.

The fourth section of Chapter 6 explores the technologies associated with connectivism, specifically, intelligent networks and artificial intelligence (AI). The pedagogical and technological sections help to clarify the theoretical formulations. These final sections also illuminate the important but as yet largely unexplored implications of connectivism for the future of online teaching and learning.

The key questions in this chapter, as in the previous chapters on behaviorism, cognitivism and constructivism, are: Does connectivism contribute to our understanding of how people learn? What are the processes that underpin and explain connectivist learning and, thus, what are the pedagogical and technological implications? The question asked by critics and even by the founders themselves is whether connectivism functions as a theory. In other words, does it contribute to our understanding of learning by explaining how learning occurs?

Connectivism as a Learning Theory and Major Thinkers

The founders and main proponents of connectivist principles as a learning theory are George Siemens and Stephen Downes. Siemens coined the term *connectivist theory* in a 2004 post to his blog at *elearnspace.org*, arguing that the concept of connectivism provided a learning theory specifically for the digital age (Siemens, 2004).

In that 2004 post, Siemens identified the following general principles as the underpinnings of connectivist thought. He wrote that:

> Learning and knowledge rests in diversity of opinions [*sic*].
>
> - Learning is a process of connecting specialized nodes or information sources.
> - Learning may reside in non-human appliances.
> - Capacity to know more is more critical than what is currently known.
> - Nurturing and maintaining connections is needed to facilitate continual learning.
> - Ability to see connections between fields, ideas, and concepts is a core skill.
> - Currency (accurate, up-to-date knowledge) is the intent of all connectivist learning activities. (Siemens, 2004)

Siemens' blog was followed by educators interested in topics related to educational technology, learning networks and open learning. His bold claim that connectivism was the *only* learning theory for the digital age because it was the *first* learning theory to consider technology gained attention in the blogosphere.

According to Siemens, previous theories of learning such as behaviorism, cognitivism and constructivism were not adequate for the digital age since they were not impacted by technology. This fact, he argues, is what makes connectivism a unique theory of learning for the digital age. Siemens (2004) opens his blog with the following statement:

> Behaviorism, cognitivism, and constructivism are the three broad learning theories most often utilized in the creation of instructional environments. These theories, however, were developed in a time when learning was not impacted through technology. Over the last twenty years, technology has reorganized how we live, how we communicate, and how we learn. Learning needs and theories that describe learning principles and processes, should be reflective of underlying social environments.

Siemens' opening argument is dramatic but inaccurate because he fails to distinguish between *online* technologies and those technologies that preceded it. As discussed in Chapters 1 and 2 of this book, human learning throughout our development has both impacted and been impacted by, has shaped and been shaped by, the communication technologies of the time. Technology and learning have been interconnected and central to human development and civilization: how we live, how we survive and how we thrive are related to the technologies we develop to communicate, collaborate and build knowledge together.

Learning technologies are not a recent phenomenon. Siemens' 2004 statement that "Over the last twenty years, technology has reorganized how we live, how we communicate, and how we learn" simplistically ignores tens of thousands of years of human development, influenced by technology. (Bates, 2015b, section 6.2).

Human invention of the technologies of speech, writing, printing and the internet have been integral to human learning and knowledge building. The invention of these communication technologies represents key paradigmatic moments when human, societal and technological development coincided to trigger major social and economic shifts and great leaps forward in civilization.

Siemens' statement, moreover, does not hold up with respect to the specific theories he cites. Asserting that the learning theories of behaviourism, cognitivism and constructivism "were developed in a time when learning was not impacted through technology" is incorrect. The major learning theories of the 20th century shaped and were shaped by the emerging technological developments of their time, specifically automation and the invention of electricity. For example, as discussed in Chapter 3, behaviorist learning theory was exemplified by Pressey's Teaching Machine (1924), based on the view of learning as stimulus–response. The Teaching Machine was developed to automate the role of the teacher with a mechanical device. The device provided the student with a short piece of content, followed by a multiple-choice question to assess whether the student could accurately select the correct answer from four options. Teaching and learning were reduced to a simplistic formula of *Content Delivery + Quiz*.

Chapter 4 examined the theory, pedagogy and technologies of cognitivism. The pedagogy of content transmission that Pressey sought to mechanize with his Teaching Machine (*Content Delivery + Quiz*) was refined by B. F. Skinner in the 1950s to become Programmed Instruction. Skinner was a contemporary of the invention of computers, and he was active in the application of computing to the field of education. Cognitivist learning theory was central to the development of computer-based teaching machines, especially software developed for computer-assisted learning (CAL), computer-assisted instruction (CAI), and computer-based training (CBT). With the rise of intelligent tutoring systems (ITS), and the role of AI, online courseware dramatically increased in the 1990s. Behaviorism and cognitivist learning theory emphasized didactic, individualized learning approaches.

With the immense growth of AI in the late 1990s and into the 21st century, the objectivist view of technology's potential began to shift from being a Teaching Machine to becoming a Thinking Machine. Automated teaching programs of the 1920s were refined into the CAI programs of the 1980s, and courseware of the early 1990s. These were all based on models of individualized learning. Individualized learning programs controlled by computers became increasingly powered by AI in the late 1990s with the emergence of "intelligent tutors" and in the 21st century, have led to applications such as for-profit MOOCs, personalized learning environments (PLEs) and adaptive learning systems (ALS).

While constructivist learning theory—discussed in Chapter 5—emphasized human agency, engaging the student by promoting "learning through doing," technology and group work were also emphasized. Seymour Papert's Logo technology, a computer software that encourages students to program, is linked to constructivist learning theory and emphasized active human learning and knowledge construction. Constructivism is associated with computer-based construction kits and microworlds, such as Papert's Logo system, which encouraged students to learn the Logo programming language. Lego Logo, which could manipulate robotic Lego bricks attached to a computer, was used in grade schools in the late 1980s and early 1990s. It was a precursor to Lego Mindstorms, which consisted of kits of software and hardware for students to create programmable, customizable robots.

Thus, Siemens' claim of the unique quality, nature and contribution of connectivist theory as emphasizing technology is inaccurate and misleading. Siemens misrepresents the nature of human learning practice and the role of technology since the dawn of humanity and, more recently, in the relationship between learning theory and technology.

The founders of connectivism, however, not only misinterpret the historical role of learning and technology, they fail to empirically demonstrate and define connectivism in practice. In

2012, writing about the development of the 2008 MOOC course with George Siemens, Stephen Downes comments:

> … we both decided at the outset that it would be designed along explicitly connectivist lines, *whatever those were*. Which was great in theory, but then we began almost immediately to accommodate the demands of a formal course offered by a traditional institution. (Downes, 2012a, emphasis added)

This was written in 2012, 8 years after connectivism was first proclaimed a theory and practice for the digital age. The acknowledgement that *connectivist lines and design* were not known in 2008 when the first MOOC was launched, nor was this clarified by 2012, is a testament to the enduring vagueness of the concept.

George Siemens

George Siemens is a writer, researcher, international speaker and the originator of the theory of connectivist learning. Siemens was the instructor and designer of what has been labeled as the first MOOC, an online course that was open to credit and noncredit students as part of a Certificate program in Adult Education offered by the University of Manitoba, Canada, via the internet. The subject was "Connectivism and Connectivist Knowledge" (CCK08), and the course was delivered by Siemens in 2008. The term *MOOC* was coined to describe the fact that this course was a Massive, Open, Online Course available to noncredit, nonpaying participants who would link into the course via internet connections. At the time, Siemens was the Assistant Director for the Learning Technologies Center at the University of Manitoba; he later became a researcher and strategist at Athabasca University in Alberta, Canada. He joined the University of Texas at Arlington in December 2013 as the executive director of the Learning Innovation and Networked Knowledge Research Lab (LINK Lab).

Siemens was an active blogger and his major contributions, such as his 2004 post, *Connectivism: A Learning Theory for the Digital Age*, and the 176-page online book, *Knowing Knowledge* (2006, Creative Commons), were contributions to his blog at *elearnspace.org*.

Connectivism, Siemens argued, is unique because it acknowledges technology as an active participant in learning networks. He asserted that network technology is not just a player, but possibly *the* major or decisive participant in connectivism, replacing even the role of the instructor. This is a key concept of connectivism.

> A central tenet of most learning theories is that learning occurs inside a person. Even social constructivist views, which hold that learning is a socially enacted process, promotes [*sic*] the principality of the individual (and her/his physical presence – i.e. brain-based) in learning. These theories do not address learning that occurs outside of people (i.e. learning that is stored and manipulated by technology). (Siemens, 2004)

Both Siemens and Downes emphasize "learning that occurs outside of people manipulated by technology," a theme that recurs throughout their writings on connectivism. What is never clarified is who or what controls that technology? If the learning processes and linkages are not facilitated by a human teacher, then who creates the computer algorithm that manipulates the learning interactions? Who owns it? What principles or theories of learning drive the algorithm? And based on which epistemologies of learning? Who or what controls the learning processes, connections and content when learning is manipulated by technology? These central and urgent questions are never raised. Neither Siemens nor Downes address these shortcomings or assumptions as a problem.

CONNECTIVISM VERSUS CONSTRUCTIVISM VERSUS CONNECTIONISM

Siemens' knowledge of learning theory appears relatively thin, especially in explaining the role of technology and learning. His critiques and references rest almost entirely on quoting secondary sources while he himself provides no unique reading or insight based on primary sources. He does not cite primary sources or address contributors associated with behaviorist, cognitivist or constructivist learning theories. As such, he demonstrates little substantial evidence or theoretical depth in his critiques.

The following passage, taken entirely from Siemens, is an example of his reliance on secondary sources. Note that both paragraphs below are a quote from Siemens:

> Constructivists hold learning to be a process of active construction on the part of the learner. Learning occurs as the learner "attempt [*sic*] to make sense of their experiences" (Driscoll, p. 376). The roots of constructivism can be found in the epistemological orientation of rationalism, where knowledge representations do not need to correspond with external reality (p. 377). Adherents to constructivism borrow heavily from theorists previously mentioned: Piaget, Vygotsky, and Bruner (Dabbagh, 2005; Driscoll, 2000).
>
> Learning theories and theorist classifications are contradictory. For example, Driscoll (2000) listed Bruner as a pragmatist/cognitivist, while Dabbagh (2005) listed him as a constructivist. New entrants into this space quickly find a convoluted mix of psychology, philosophy, and theory pop-culture. Discerning theories with underlying assumptions of learning is challenging. Particularly confusing is the theory of constructivism, which researchers tend to treat as a banner under which to fly numerous aspects and new views. It has come to mean everything, anything, and nothing. While not as acerbic, Driscoll stated, "There is no single constructivist theory of instruction. Rather, there are researchers in fields from science education to educational psychology and instructional technology who are articulating various aspects of constructivist theory" (p. 375). Additionally, it may be unclear whether constructivism is actually a theory or a philosophy (p. 395). (Siemens, 2006)

Siemens, repeating the critiques of others, questions "whether constructivism is actually a theory or a philosophy." However, he is unable to advance this issue. In fact, in a 2007 blog post, *Informal Learning: All or Nothing*, Downes criticizes Siemens for linking or confounding connectivism with social constructionism:

> It's kind of like saying, "I support informal learning, except when I don't." George [Siemens] does the same thing when he describes Connectivism. "I don't care whether you call it social constructionism." I am not sure how to react – are you saying there is no fundamental difference between your position and the other position? (Downes, 2007a)

While Downes critiqued Siemens' equivocal position on the relationship between connectivism and constructivism, there are greater problems with the relationship implied by Siemens and Downes between connectivism and a number of other theories.

Siemens' definition of connectivism frequently suggested a relationship to other theories, most often computational theories. For example, Siemens (2004) writes:

> Connectivism is the integration of principles explored by chaos, network, and complexity and self-organization theories. Learning is a process that occurs within nebulous environments of shifting core elements – not entirely under the control of the individual. Learning

> (defined as actionable knowledge) can reside outside of ourselves (within an organization or a database), is focused on connecting specialized information sets, and the connections that enable us to learn more are more important than our current state of knowing.

This reference to an assortment of principles and theories does not result in a coherent statement of what defines or distinguishes connectivist learning. Declaring that connectivism is the "integration of principles explored by chaos, network, and complexity and self-organization theories" is not meaningful unless those principles are identified, examined and their relationship to processes of learning specified and confirmed. Siemens' writings reflect the condition which he himself critiques in constructivism when he wrote: "New entrants into this space quickly find a convoluted mix of psychology, philosophy, and theory pop-culture. Discerning theories with underlying assumptions of learning is challenging" (Siemens, 2006). The critique that Siemens makes of constructivism seems eerily applicable to his description of connectivism: "It has come to mean everything, anything, and nothing" (ibid.).

CONNECTIVISM VERSUS CONNECTIONISM

Siemens frequently links his connectivist model to various computational theory rock stars. One clear example is his attempt to relate connectivism to the theory of connectionism (connectionism is a theory in the field of AI). Both Siemens and Downes frequently refer to connectionism in their writings, suggesting that connectivism shares a similar conceptual framework with connectionism. The relationship with connectionism, while often suggested by the founders of connectivism, is never empirically established nor can it be. The two are very different.

Connectionism, as distinct from connectivism, is a well-respected AI research approach that examines how intelligence might emerge from the activity of networks of neuronlike entities. In their classic book, *Perceptrons: An Introduction to Computational Mathematics* (expanded edition 1988), Marvin Minsky and Seymour Papert built on what were at the time new developments in mathematical tools, psychological models of how the brain works and the evolution of fast computers that could simulate neural networks in the brain to advance the theory of connectionism, with special relevance to machine learning and AI.

Connectivism, on the other hand, is not related to computer science research or theory; there are no theoretical, methodological or empirical associations between connectivism and connectionism.

Nonetheless, while Siemens states that there are differences between connectionism and connectivism, his comments imply that there are significant commonalities. "Connectivism shares some traits of the cognitive science view of connectionism—the view that learning is a process of network formation" (Siemens, 2006). He continues:

> For clarification, it is important to briefly consider connectionism in contrast with connectivism. Connectionism is based in behaviorism (Thorndike, as cited in Kearsley, n.d.), where learning occurs as we form links between stimulus and response. Connectionism, in terms of neuro/cognitive science, is focused on neural networks—the manner in which we learn—contrasted with previous views of learning as information processing (Garson, 2002). Connectivism shares some traits of the cognitive science view of connectionism—the view that learning is a process of network formation.
>
> Connectionism is only focused with learning that happens in our heads. Connectivism is focused on the process of forming and creating meaningful networks that may include technology-mediated learning, acknowledges [*sic*] learning that occurs when we dialogue with others, i.e., we collect knowledge in our friends (Stephenson, n.d.) and such.

> Connectivism is strongly focused on the linking to knowledge sources … not simply trying to explain how knowledge is formed in our own heads.
>
> The more rapidly knowledge develops the less likely it will be that we will possess all knowledge internally. The interplay of network, context, and other entities (many which are external) results in a new approach or conception of learning. The active creation of our own learning networks is the actual learning, as it allows us to continue to learn and benefit from our network—compared to a course which has a set start and end date. (Siemens, 2006)

Siemens implies that connectivism may even be superior to connectionism, while ignoring how the two are connected. Suggestions of the link between connectivism and connectionism are found in other writings by Siemens. He hints that connectionism and the science of neural networks in some way reinforce connectivism, although this is never seriously pursued nor validated.

> Connectivism addresses the principles of learning at numerous levels – biological/neural, conceptual, and social/external. This is a key concept that I'll be writing about more during the online course. What I'm saying with connectivism (and I think Stephen [Downes] would share this) is that the same structure of learning that creates neural connections can be found in how we link ideas and in how we connect to people and information sources. One scepter to rule them all. (Siemens, n.d.)

Connectionism is a well-respected theory that examines the potential role and function of neural networks, while connectivism is all too often a play on the word "network." Siemens leaves unexplained how learning occurs, or how networks contribute to learning. Comments such as "one sceptre to rule them all" suggests a commonality among biological/neural networks, conceptual networks and social/external networks, without demonstrating common definitions or applications of network structures and network principles. This vast oversimplification is meaningless yet reappears in various forms in Siemens' writings: the implication that neural networks (brain learning) + social networks + online networks = connectivist learning (learning networks). This simplistic formula is never developed, nor does Siemens ever return to address it in his writings.

Stephen Downes, co-founder of connectivism, suggests that he was part of the original community involved with the development of neural networking:

> In a similar manner, we will see future technologies increasingly modeled on newer theories of mind. The "neural nets" of connectionist systems are exactly that. The presumption on the part of people like Minsky and Papert is that a computer network will in some sense be able to emulate some human cognition—and in particular things like pattern recognition. Even Quine was headed in that direction, realizing that, minimally, we embody a "web of belief."
>
> For my own part, I was writing about networks and similarity and pattern recognition long before the internet was anything more than a gleam in my eye. The theory of technology that I have follows from my epistemology and philosophy of mind. This is why I got into trouble in my PhD years—I was rejecting the cognitivism of Fodor, Dretske and Pylyshyn, and concordantly, rejecting the physical symbol system hypothesis advanced by people like Newell and Simon. (Downes, 2007b)

Statements by both Downes and Siemens are frequently very grand but typically unsupported trivial. For example, Downes' reference to his research as being "long before the internet was anything more than a gleam in my eye" is without meaning, evidence or relevance. Siemens adopts a flippant tone when addressing core issues related to connectivism, treating important points as a nuisance or even ridiculing them. For example, in 2006 he addresses the nature of connectivism in a blog post entitled: "Connectivism: Learning theory or pastime for the self-amused?" Which is it? It is not clear from the text.

In 2011 Siemens posted "From knowledge to bathroom renovations", stating that he consciously dodges questions about his view of knowledge or what distinguishes connectivism from constructivism:

> I've learned to run, frantically, from questions like:
> - *How old do you think I am*?
> - *Does this outfit make me look fat*? and
> - *What is knowledge*?
>
> (I'm soon going to upgrade "*how is connectivism different from constructivism*" to the "run" status. Right now it's more of a "stroll away" question). (Siemens, 2011c, emphasis added)

Stephen Downes

Stephen Downes, a researcher at the National Research Council of Canada, has been involved in online education since 1995, primarily as a "futurist" commentator, and for a few years as an instructional designer. In a 2011 biography, Downes writes that he "introduced the concept of e-learning 2.0 and, with George Siemens, developed and defined the concept of connectivism, using the social network approach to deliver open online courses to three thousand participants over two years" (Downes, 2011).

In 2012, Downes wrote:

> In recent years I have been working on two major concepts: first, the connectivist theory of online learning, which views learning as a network process; and second, the massive open online course, or MOOC, which is an instantiation of that process. (Downes, 2012b)

Downes produced a 600+ page ebook online, *Connectivism and Connective Knowledge: Essays on meaning and learning networks*, that was self-published under a Creative Commons License in 2012. The book curates his writings and presentations over the past decade, and his perspective on how connectivism explains learning. In the Introduction Downes writes:

> Learning is the creation and removal of connections between the entities, or the adjustment of the strengths of those connections. A learning theory is, literally, a theory describing how these connections are created or adjusted. In this book I describe four major mechanisms: similarity, contiguity, feedback, and harmony. There may be other mechanisms, these and others may work together, and the precise mechanism for any given person may be irreducibly complex. (Downes, 2012c, p. 9)

In the above quote, Downes defines "learning theory" as *describing* how learning occurs. Such a definition is incorrect. A theory should explain the process by which learning occurs, not merely describe a phenomenon. Many key concepts and terms are not explained by Siemens, Downes or others. For example: What defines or distinguishes a *connection*? What is a connection in connectivism? How *do connections generate learning*? What needs to happen to make connections lead to learning? What *kinds of connections* yield or generate learning?

Other terms apparently foundational to connectivism, such as *nodes*, *elements* and *entities*, are also not defined.

Critics and adherents have noted that connectivism as a theory does not provide a clear or concrete explanation of how learning occurs and, thus, a theory fails to materialize. Even the founders, who generate lists of principles, of qualities and of references to complex computational theories, have been unable or unwilling to explain how these qualities, principles or computation theories connect to generate learning.

Moreover, the level of contradiction and dispute between the two founders further complicates attempts to make sense of connectivism. Siemens and Downes are frequently feuding and disagreeing. They have never jointly defined or co-authored a publication that presents a unified definition of connectivist *learning theory*, nor addressed how connectivism explains learning. Frequently, their exchanges have been in the form of debate and, increasingly, disagreement rather than joint development. Consequently, there are no unified or comprehensive definitions, concepts or a clear *theory* of connectivism.

A typical example is Downes' post entitled: "The vagueness of George Siemens" (posted to his blog, *Half an Hour*). The attack is intense but fails to help illuminate any significant aspect of connectivism. Downes writes:

> I like George Siemens, and he says a lot of good things, but his imprecision can be frustrating. For example, in his discussion of my work on connective knowledge, he observes, "In this model, concepts are distributed entities, not centrally held or understood … and highly dependent on context. Simply, elements change when in connection with other elements." What does he mean by "elements"? Concepts? Nodes in the network? Entities? You can't just throw a word in there; you need some continuity of reference …
>
> Then he says, "I still see a role for many types of knowledge to hold value based on our recognition of what is there." Now I'm tearing my hair. "Hold value?" What can he mean … does he know? Does he mean "'Snow is white' is *true* if and only if snow is white?" Or is he simply kicking a chair and saying, "Thus I refute Berkeley." In which case I can simply recommend *On Certainty* (one of my favourite books in the world) and move along …
>
> Here is his main criticism: "At this point, I think Stephen [Downes] confuses the original meaning inherent in a knowledge element, and the changed meaning that occurs when we combine different knowledge elements in a network structure." Well I am certainly confused, but not, I think, as a result of philosophical error. What can Siemens possibly mean by "knowledge element." It's a catch-all term, that refers to whatever you want it to—a proposition, a concept, a system of categorization, an entity in a network. But these are very different things—statements about a "knowledge element" appear true only because nobody knows what a "knowledge element" is.
>
> He writes, "Knowledge, in many instances, has clear, defined properties and its meaning is not exclusively derived from networks…" What? Huh? If he is referring to, say, propositions, or concepts, or categorizations, this is exactly not true—but the use of the fuzzy "knowledge elements" serves to preclude any efforts to pin him down on this. And have I ever said, "meaning is derived from networks?" No—I would never use a fuzzy statement like "derived from" (which seems to suggest, but not entail, some notion of entailment) …
>
> What is Siemens's theory of meaning? I'm sorry, but I haven't a clue. He writes, "The fact that the meaning of an entity changes based on how it's networked does not eliminate its

> original meaning. The aggregated meaning reflects the meaning held in individual knowledge entities." An entity—a node in a network? No. He has to be saying something like this: for any given description of an event, Q, there is a *fact of the matter*, P, such that, however the meaning of Q changes as a consequence of its interaction with other descriptions D, it remains the case that Q is at least partially a function of P, and never exclusively of D. But if this is what he is saying, there is any number of ways it can be shown to be false, from the incidence of mirages and visions to neural failures to counterfactual statements to simple wishful thinking.
>
> But of course Siemens doesn't have to deal with any of this because his position is never articulated any more clearly than "Downes says there is no fact of the matter, there is a fact of the matter, thus Downes is wrong." To which I reply, simply, show me the fact of the matter. Show me one proposition, one concept, one categorization, one anything, the truth (and meaning) of which is inherent in the item itself and not as a function of the network in which it is embedded. (Downes, 2007d)

This is just one of many posts in which Downes attacks Siemens on fundamental issues, challenging his credibility. Such passages do little to advance our collective understanding of connectivism, nor do they provide credibility to the concept.

Comments and critiques

The notion that connectivism represents a new theory of learning has generated some debate and critique, but overall the theory has lost lustre and credibility in recent years even as for-profit "connectivist" courses continue to receive backing from business enterprises.

As we have seen, a significant stumbling block is the lack of a cohesive, collective presentation of a connectivist theory, its fundamental concepts and supporting empirical data.

A related challenge is the dearth of scholarly publication on the topic of connectivism by its founding proponents or others. Both Siemens and Downes use blogs as their main communication channel for broadcasting their ideas on connectivist learning and on MOOCs. The result, researchers and educators have argued, is that neither Downes nor Siemens have defined or presented connectivism in an organized and clear fashion to their peers, and hence have limited the opportunities for scholarly discussion, debate or development.

Elearning and distance education consultant, Tony Bates, notes:

> I have to say that I have struggled for some time both to understand exactly what is the theory of connectivism, other than the importance of online social networks for learning, which I agree with but don't find particularly helpful in pragmatic terms, and I've also struggled to understand the extent to which learning actually takes place within a connectivist framework. In other words, I have been looking for a more coherent theoretical framework, and some empirical evidence to support the theory. (Bates, 2011)

The main purpose of scholarly publication is to present scholarship (theoretical or empirical) in an organized and scientific format to peers and members of the knowledge community (i.e., those who work in the same field—to make a contribution to knowledge). By providing clear definitions, reviewing the related literature and specifying what and how new ideas are being advanced, the scientific format enables others to understand the nature of the work and to assess whether it offers a contribution to the state-of-the-art.

Posting notes and comments to one's own blog is not a cause for criticism in itself. However, in the case of Siemens and Downes, blog posts have been primarily one-way pronouncements, with little scholarly or public interaction. And, most importantly, posting to one's blog does not replace presenting work for scholarly examination and peer critique. In the case of Siemens and Downes, this occurred only rarely.

Siemens and Downes have both, in various posts, acknowledged the key problem: they are unable to define or agree on what "connectivism" is and how to apply it. Even during their formative period, they acknowledged that while they *sought* to design their CCK08 course "along explicitly connectivist lines, *whatever those were*," they "began almost immediately to *accommodate the demands of a formal course offered by a traditional institution*" (Downes, 2012a, emphasis added). Moreover, Downes writes: "We were hesitant to teach people something definitive when even we did not know what that would be" (ibid.). This was written eight years after connectivism was presented as a theory.

The founders were apparently also stumped by what a theory really meant. Downes states the belief that "any articulation of the theory, any abstraction of the principles, *distorts it*" (ibid., emphasis added). To state that the articulation of a theory distorts it is a fundamental misunderstanding or misrepresentation of the role of theory. Why then, one wonders, did they then continue to promote the concept of a *theory* of connectivism? Connectivism as a theory of learning has not only been neglected (it has not been defined, demonstrated or empirically validated), it has been abandoned by its founders. Neither founders nor followers have demonstrated a significant attempt to develop or validate the theory.

As presented in the passage below, the intention of the founders and followers was apparently to teach something they call "fuzzy reality." In 2015, Downes wrote:

> In the case of CCK08, there *is* no core body of knowledge. Connectivism is a theory in development (many argued that it isn't even a theory), and the development of connective knowledge even more so. …
>
> Even more importantly, identifying and highlighting some core principles of connectivism would undermine what it was we thought connectivism was. It's not a simple set of principles or equations you apply mechanically to obtain a result. Sure, there are primitive elements – the component of a connection, for example – but you move very quickly into a realm where any articulation of the theory, any abstraction of the principles, distorts it. The fuzzy reality is what we want to teach, but you can't teach that merely by assembling content and having people remember it. (Downes, 2012a)

Clearly, the definition of connectivism has not been resolved. And there has been no resolution of the central contradiction between the theory and the design of the first connectivist course (CCK08), where Siemens and Downes stated that it would be contradictory to present connectivism as a body of content, but immediately found themselves doing just that.

For those on the outside trying to make sense of it all, the lack of any clear basic concepts, combined with contradictory practical examples, leave us intellectually adrift.

Moreover, rarely do the founders of connectivism address what they have learned; this is a loss to the field, given their experiences since 2008 when they implemented the first MOOC course. This also disrespects the accepted rigors of theory building which require empirical confirmation (or negation), given that the founders themselves chose the path of deductive reasoning, and thus must be aware of the critical need to follow up with supporting evidence to confirm or negate the theory. Scholarly and ethical requirements have been ignored. Instead, in 2012, having taught several MOOC courses on connectivism, Downes posted the following conclusions:

> What we've learned – at least to me – is that cooperation is better than collaboration, that diversity is better than sameness, that harmony is better than competition, that openness is

> better than exclusivity, and that understanding complexity is better than reduction to simplicity. These are, to my mind, the *opposite* of the bases on which traditional education is designed. Does that make connectivism a theory? In a real sense, that question is irrelevant. "Theory" implies principles and abstraction; connectivism is, in practice, the opposite of that. (Downes, 2012a)

The conclusions presented above are puzzling and disappointing from a theoretical and research perspective. The concepts are not defined and the conclusions are not supported: What do they mean? Why is cooperation better than collaboration? Based on what evidence? And how are cooperation and collaboration defined and/or distinguished? Are these activities part of the definition of connectivism? Where do they appear in the theory or pedagogy? How did Downes arrive at these conclusions? And most importantly why, after all his promotion and marketing of the term, is the question of whether connectivism is a theory now declared to be "irrelevant"?

As can be deduced from the published exchanges between Siemens and Downes, the conceptual framework for connectivism is incomplete, ambiguous and contradictory. While they attack one another, the reality is even more confounding for any scientific or theoretical discussion of the term. The conundrum is that although the term connectivism retains some currency in public discussions, it remains outside the rigors of the scientific community on learning theory. There has been no research on applications of connectivist approaches, no contribution of empirical evidence to developing the theory, nor development of the theoretical framework of how people learn using connectivist approaches.

Connectivist Learning Pedagogy: The MOOC

Connectivist proponents are not the first to try to diminish or eliminate the role of the instructor in learning. Since the rise of manufacturing in the 19th century, attempts to mechanize or automate teaching have been ongoing. The attempt to build and use teaching machines reflects objectivist epistemology: the belief in truth and efforts to improve the transmission of that truth. Learning, in this view, is not related to student comprehension but simply to obedience and replication. In other words, learning is defined as repetition of transmitted content: learning = content + quiz. Automation and efficiency (*transmission costs, time and quantity*) were the key values.

The most recent and sweeping example of the automation of education is the connectivist-inspired American MOOC (massive open online course). The MOOC pedagogy is essentially the same as that of the mechanical Pressey Teaching Machine: to automate the transmission of *content+quiz*. MOOCs do this through online transmission of video lectures and auto-graded quizzes. Video lectures of 8–12 minutes in length are presented followed immediately by a multiple-choice quiz that is auto-graded and provides the results to the learner within seconds.

This approach is similar to courseware: instruction without an instructor. While courseware took advantage of early AI technologies such as intelligent tutoring systems and expert systems, for-profit MOOCs companies have invested heavily in the latest advances in AI and machine learning. The founders of the major MOOC providers (Andrew Ng and Daphne Koller of Coursera and Sebastian Thrun of Udacity) are in fact professors of AI and machine learning, which helps to explain their approach to online education. The use of AI in the MOOC industry is not entirely clear or made public, but it includes simple tasks such as course registration, video content transmission, autograding and user verification. Additionally, huge investments are being made in massive data mining of all types of data on student actions, facial expressions and body movement to seek patterns of learning, cognitive processes, emotional inputs, time on task, processes used by learners and a host of other activities. Cathy Sandeen, of the Center for Education, Attainment and Innovation, writes: "One of the most exciting aspects of

MOOCs is the rapid experimentation. … the use of predictive analytics" (Sandeen, 2013). Jason Mock describes the interest by the University of Illinois in:

> how we can leverage the tens of thousands of students for our benefit—we are trying to help them, but they can help us as well. Think about the emotions and thoughts we have when contemplating tens of thousands of people at once. What do we gain from them? We gain a lot of data. Every click, every video pause. There are research projects going on right now. (Mock, 2013)

Tapping into big data, researchers build mathematical models of personal, cognitive and social behavior. Data mining of human behavior in social media and other massive online environments such as MOOCs, seeks, among other things, to identify and analyze how the brain works, a sort of plagiarism of the human mind or reverse engineering to advance AI development.

The First MOOC

In 2008, George Siemens taught a University of Manitoba online course that was part of a Certificate in Adult Education titled "Connectivism and Connective Knowledge" (CCK08). Siemens invited Stephen Downes to be co-instructor. This course became known as the original massive, open, online course or MOOC.

The initial exploration and conceptualization of CCK08 as a MOOC and as an embodiment of connectivist learning theory involved several other educators as well, such as Dave Cormier, Alec Couros and Leigh Blackall, in addition to Siemens and Downes. They contributed to the conceptualization of the original design of the course and the concept of a MOOC.

As the first recognized MOOC course, CCK08 was taught in 2008 to 25 students seeking to obtain a Certificate in Adult Education offered by the University of Manitoba. The instructors experimented with *open participation* (free to members of the public who could access the course resources and participate in the discussions without paying a fee or receiving a course credit), *open content* (using free resources available online) and participant *self-organization* (no instructional organization or input such as course design, course topics, course schedule or curriculum). Approximately 2,300 nonpaying, not-for-credit participants signed on to the online CCK08.

Of the 2,300 participants, few were active in reading and posting messages. According to Duncan Kinney, the majority of the 2,300 online participants received the daily updates but did not contribute, or essentially dropped out. Referring to the percentage level of active participation, Kinney stated that: "It was more 90–10 and of that 10 per cent it was probably one per cent that were really active" (Kinney, 2011).

The course design for CCK08 was not clearly established. Although it was a formal university credit course for the 25 registered students, Cormier and Downes approached it as an informal experiential event in which the participants would engage in a form of self-directed online learning, pursuing their own interests and connecting with others as they wished.

Cormier describes the "design" of the CCK08 course and how it would function:

> The course used network technologies (such as an RSS feed, similar to the twitter hashtag) to link comments made in various other communication networks. The course topics were general and it was intended that participants would "self-organize" to form interest groups. The upshot of it was that it really was going to be an open course, and the instructors were going to allow the students to form whatever groups they might be interested in and they would provide the communication stream but not the organizational scaffolding. (Cormier, 2008)

There was to be no involvement by the instructor in creating a course design or providing a curriculum and course content. The role of the instructors was to provide a means to link the messages sent by participants, to solely "provide the communication stream" (ibid.). The instructors were heavily involved in the technological aspects. Stephen Downes compiled all the posts sent by students each day into a blog called *The Daily*, which served as the central stream of discussions.

Cormier notes the daunting technological roles of the instructors:

> There are a variety of ways in which learners in the connectivism course are being distributed to the world … Overall the communications weight on George and Stephen is huge, they're involved in a large number of conversations, and have been trying to follow the vast weight of the content that has been produced … not sure this is a sustainable model, nor would it necessarily work as well for a different teacher who didn't already spend a large amount of time working on the web. (ibid.)

Students communicated using technologies such as Moodle discussion forums, Google Groups, Second Life, *The Daily* (a blog where the various course comments were aggregated), the course wiki (which ultimately functioned as a curriculum) and synchronous communication media such as Eluminate and ustream.

Cormier notes that a course wiki was created to function as a collaborative syllabus, to showcase participant contributions. However, the collaborative or interactive function of the wiki was not realized:

> I think that the syllabus can be very helpful, but the work there has not really been worked on by anyone other than Stephen and George … not much sense having a wiki when only the administrators end up working in it. (ibid.)

In two separate blog postings, Stephen Downes provides rare insight into the invention, formulation and challenges of CCK08:

> When George Siemens and I created the first MOOC in 2008 we were not setting out to create a MOOC. So the form was not something we designed and implemented, at least, not explicitly so. But we had very clear ideas of where we wanted to go, and I would argue that it was those clear ideas that led to the definition of the MOOC as it exists today.
>
> We set up Connectivism and Connective Knowledge 2008 (CCK08) as a credit course in Manitoba's Certificate in Adult Education (CAE), offered by the University of Manitoba …
>
> What made CCK08 different was that we both decided at the outset that it would be designed along explicitly connectivist lines, whatever those were. Which was great in theory, but then we began almost immediately to accommodate the demands of a formal course offered by a traditional institution. The course would have a start date and an end date, and a series of dates in between, which would constitute a course schedule. Students would be able to sign up for credit, but if they did, they would have assignments that would be marked (by George; I had no interest in marking).
>
> But beyond that, the course was non-traditional. Because when you make a claim like the central claim of connectivism, that the knowledge is found in the connections between people with each other and that learning is the development and traversal of those connections, then you can't just offer a body of content in an LMS and call it a course. Had we simply presented the "theory of connectivism" as a body of content to be learned by participants, we would have undercut the central thesis of connectivism.

> Running the course over fourteen weeks, with each week devoted to a different topic, actually helped us out. Rather than constrain us, it allowed us to mitigate to some degree the effects an undifferentiated torrent of content would produce. It allowed us to say to ourselves that we'll look at "this" first and "that" later. It was a minimal structure, but one that seemed to be a minimal requirement for any sort of coherence at all. Even so, as it was, participants complained that there was too much information. This led to the articulation of exactly what connectivism meant in a networked information environment, and resulted in the definition of a key feature of MOOCs. Learning in a MOOC, we advised, is in the first instance a matter of learning how to select content. By navigating the content environment, and selecting content that is relevant to your own personal preferences and context, you are creating an individual view or perspective. So you are first creating connections between contents with each other and with your own background and experience. And working with content in a connectivist course does not involve learning or remembering the content. (Downes, 2012a/b)

Connectivism founders contradict themselves time and again regarding connectivist pedagogy. In a June 2011 response to criticism by David Wiley that the lack of course structure in MOOC courses renders them inaccessible and a poor fit for the academically under-served, Siemens states that in fact he has no problem with formal course structure or assessment.

> David states, "Inasmuch as MOOCs seem to be allergic to structure, and go out of their way to avoid structures that would place any kind of requirement (or even moderately strong suggestion) on anyone, they appear to be an extremely poor fit for individuals who are not well prepared academically."
>
> I personally don't avoid structure and I don't avoid assessment or grading. I've graded students in all three of the CCK offerings. For our upcoming MOOC, several universities are considering offering credit for the course (Georgia Tech and Athabasca U). Both will be building assignment criteria around the course to ensure credibility. (Siemens, 2011a)

The definitions and the practices of what constitutes connectivist pedagogy are idiosyncratic and inconsistent. Beyond the problems of defining connectivist pedagogies, there is a dearth of empirical results. The results of the early MOOCs have never been published or reported. As Kinney noted, only about 1% of the 2,300 registrants were active, which is about 23 participants, roughly the number of students who had registered for credit.

The results foretold much of what the US MOOCs' efforts experienced in 2012–2016.

cMOOCs and xMOOCs

Siemens introduced the terms cMOOC and xMOOC in his 2012 blog, to differentiate two types of MOOC offerings: cMOOCs were distinguished as based on "ideology" whereas, according to Siemens, xMOOCs were well-funded, for-profit enterprises such as Coursera and Udacity.

> Largely lost in the conversation around MOOCs is the different ideology that drives what are currently two broad MOOC offerings: the connectivist MOOCs (cMOOCs?) that I have been involved with since 2008 (with people like Stephen Downes, Jim Groom, Dave Cormier, Alan Levine, Wendy Drexler, Inge de Waard, Ray Schroeder, David Wiley, Alec Couros, and others) and the well-financed MOOCs by Coursera and edX (xMOOCs?). (Siemens, 2012)

Bates (2015b) addresses what he views as pedagogical differences:

> Although to date there has not been a great deal of published information about the use of learning analytics in xMOOCs, the xMOOC platforms have the capacity to collect and analyse "big data" about participants and their performance, enabling, at least in theory, for immediate feedback to instructors about areas where the content or design needs improving and possibly directing automated cues or hints for individuals. … xMOOCs therefore primarily use a teaching model focused on the transmission of information, with high quality content delivery, computer-marked assessment (mainly for student feedback purposes), and automation of all key transactions between participants and the learning platform. There is rarely any direct interaction between an individual participant and the instructor responsible for the course, although instructors may post general comments in response to a range of participants' comments.
>
> cMOOCs have a very different educational philosophy from xMOOCs, in that cMOOCs place heavy emphasis on networking and in particular on strong content contributions from the participants themselves. Indeed, there may be no formally identified instructor, although "guest" instructors may be invited to offer a web cast or a blog for the course.
>
> Identifying how these key design features for cMOOCs are turned into practice is somewhat more difficult to pinpoint, because cMOOCs depend on an evolving set of practices. Most cMOOCs to date have in fact made some use of "experts," both in the organization and promotion of the MOOC, and in providing "nodes" of content around which discussion tends to revolve. In other words, the design practices of cMOOCs are still more a work in progress than those of xMOOCs. (Bates, 2015b)

Hollands and Tirthali, in their 200+ page report "MOOCs: Expectations and Realities," published in May 2014, explored the available evidence on whether or not MOOCs were achieving the early predictions that they would provide quality education on a mass scale, at low cost, and more specifically what goals were in fact being achieved. They wrote:

> It is curious that MOOCs have taken hold without much evidence as to whether they are effective in improving participant skills and knowledge, or in addressing other objectives, and without an idea of their economic value or resource requirements. As Means et al. (2014) observe, "Both irrational exuberance and deep-seated fear concerning online learning are running high" (p. 42). If decision-makers are to make rational decisions about engaging in MOOC production, it is critical to know whether MOOCs are both effective and cost-effective in delivering quality education or related outcomes. (Hollands & Tirthali, 2014, pp. 20–21)

In a September 2014 article entitled "The MOOC Revolution That Wasn't," Dan Friedman writes:

> Three years ago this week, Sebastian Thrun recorded his Stanford class on Artificial Intelligence, released it online to a staggering 180,000 students, and started a "revolution in higher education." Soon after, Coursera, Udacity and others promised free access to valuable content, supposedly delivering a disruptive solution that would solve massive student debt and a struggling economy. Since then, over 8 million students have enrolled in their courses.
>
> This year, that revolution fizzled. Only half of those who signed up watched even one lecture, and only 4 percent stayed long enough to complete a course. Further, the audience for MOOCs already had college degrees so the promise of disrupting higher education failed to materialize. The MOOC providers argue that completion of free courses is the

> wrong measure of success, but even a controlled experiment run by San Jose State with paying students found the courses less effective than their old-school counterparts…
>
> The *future* of online learning isn't about accessibility: it's about taking what we already know works offline and combining it with what you can only do online to create the most engaging experience. We're all still searching for the right formula, but the ingredients will be the same as they've always been: Learning through exploration, thoughtfully designed for the right behaviors, with great teachers providing support. (Friedman, 2014)

Connectivism promoted the concept of network-organized online courses, in which the role of the teacher or instructor would be replaced by network intelligence that would identify the path and connections needed by a learner. Connectivist cMOOCs were thus distinguished by the fact that there was no teacher, instructor or course designer to organize and design the course and structure the activities. This role would be replaced by network intelligence which would identify the learner's interests, facilitate the learning connections and respond to a learner's questions and needs. Teaching would become the mandate of the technology.

The xMOOCs, which represent highly structured courses, are frequently distinguished from what appears to be their opposite, the unstructured connectivist cMOOCs. However, ironically, the design of both xMOOC and cMOOC "connect" at a very basic level: both promote teacherless courses in which intelligent networks identify the content and connections, making key decisions for the students.

Connectivist Learning Technologies: The Role of Artificial Intelligence and Machine Learning

Both George Siemens and Stephens Downes ascribe to technology a role of tremendous power. Intelligent networks (based on artificial intelligence) are a central force in connectivist ideology. AI in effect replaces the teacher in organizing the curriculum, the information connections and directions for each learner.

Siemens assigns to technology a role that is superior to human direction; technology is presented as an active, quasi-sentient and superior actor in the network.

> Connectivism focuses on the inclusion of technology as part of our distribution of cognition and knowledge. Our knowledge resides in the connections we form – where to other people or to information sources such as databases [*sic*]. Additionally, technology plays a key role of 1) cognitive grunt work in creating and displaying patterns, 2) extending and enhancing our cognitive ability, 3) holding information in ready access form (for example, search engines, semantic structures, etc). … Connectivism acknowledges the prominence of tools as a mediating object in our activity system, but then extends it by suggesting that technology plays a central role in our distribution of identity, cognition, and thereby, knowledge. (Siemens, undated)

Recall that in his 2004 declaration of connectivism as a theory of learning for the digital age, Siemens noted that one of the key principles of connectivism was that: "Learning may reside in non-human appliances." Appliances, he argued, can learn and technologies can be active participants in a learning network. Technology (network intelligence) can provide a much more active role than storing learning: technology will *manipulate*—not merely mediate the learning. The teaching machine becomes a thinking machine.

Downes similarly demonstrates unquestioning faith in the decision-making abilities of computer networks, writing in 2007:

> The purpose of the Learning Networks project, over and above the theorizing, is to build (or help build) the sorts of tools that, when used by largish numbers of people, result in a *self-organizing network*. The idea is that, when a person needs to retrieve a certain resource (which he or she may or may not know exists) … the network will reorganize itself so that this resource is the most prominent resource. Such a network would never need to be searched – *it would flex and bend and reshape itself minute by minute according to where you are, who you're with, what you're doing, and would always have certain resources "top of mind"* would [*sic*] could be displayed in any environment or work area. Imagine, for example, a word processor that, as you type your paper, suggests the references you might want to read and use at that point. *And does it well and without prejudice (or commercial motivation)*. Imagine a network that, as you create your resource, can tell you exactly what that resource is worth, right now, if you were to offer it for sale on the open market. … That's what I'm working on. In a nutshell. (Downes, 2007c, emphasis added)

Downes presents network intelligence as a neutral albeit omnipresent authority that will organize human activities "well and without prejudice (or commercial motivation)." The writings of Downes and Siemens suggest a techno-utopianism. Technology is presented as superior to human educators. It is this view perhaps, more than anything else, that distinguishes connectivism. Technology is promoted as an active and quasi-sentient participant in the network, superior to the teacher.

Although neither Siemens nor Downes specifically refer to AI, the role that they ascribe to network intelligence suggests more than a database; the intelligence they describe suggests machine learning, a form of AI that started to flourish in the 1990s which enables decision-making by the computer software based on repeated interactions with the participants, historical relationships and trends in the data. The intelligence "learns" to predict what the learner seeks and is able to increasingly organize the links to resources to meet that search. Network intelligence has grown beyond the machine pattern recognition of its early days to increasingly rely on machine learning to make sense of and predict in a way that replicates and could eventually surpass and replace human learning.

Andrew Ng, co-founder of Coursera and professor at Stanford University, defines machine learning as follows:

> Machine learning is the science of getting computers to act without being explicitly programmed. In the past decade, machine learning has given us self-driving cars, practical speech recognition, effective web search, and a vastly improved understanding of the human genome. Machine learning is so pervasive today that you probably use it dozens of times a day without knowing it. Many researchers also think it is the best way to make progress towards human-level AI. (Ng, 2014)

The definition of "digital" does not mean merely mechanized or automated: it means that the media is based on and controlled by AI. As discussed in the next section, digital media are fundamentally different from analog media—unprecedented, unknowable and thus far more uncontrollable in their power over humanity.

Handing the Baton to AI: The Danger of Digital

While self-correcting texts are frustrating when the wrong word is posted, unnoticed by the author until the response causes consternation or laughter, imagine the consequences when AI not only suggests an inappropriate word, but actually sends us in the wrong direction as we search for information or ideas? How can we trust the network technology to determine sources or references or even definitions? How can users trust that the search engine is generating information that is not incomplete, biased, inaccurate or misleading?

Charles Seife, a professor of journalism at New York University has won many awards for his books on this topic, such as *Proofiness*, *Zero* and, in 2014, *Virtual Unreality: Just Because The Internet Told You How Do You Know That It's True?*

Seife writes that digital media are distinct from previous social media because of the AI that characterizes digital media; while the content may be the same (audio, video, print, etc.), nonetheless digital is fundamentally different from analog. Digital is distinctive, far more potent and represents something that humans have never before encountered. Digital media today is a form of AI and that changes everything; it is unprecedented in its level of power over our minds and our being.

Digital media introduces a profound paradigmatic shift in the nature of information because it represents a combination of entirely new physical properties that were never before possible (Seife, 2014, p. 4). Digital media, Seife writes:

1. can move around the world at the speed of light;
2. can be stored in virtually no space at all;
3. can be stored without fear of decay or degradation;
4. can be copied with perfect fidelity at almost no cost. (ibid.)

The consequences of digital media are profound. Seife compares digital media to *a superbug of the mind*, infecting human ability and processes of thinking!

> These very properties make digital information a superbug of the mind, something that spreads unbelievably rapidly, infects all corners of society, and becomes all but impossible to control … When we learned to turn all information into bits and bytes, we unleashed an entirely new creature upon the world, one whose powers—and dangers—we only dimly understand. (ibid.)

Seife calls this phenomenon *reality engineering*. He compares reality engineering to genetic engineers. In recent years, genetic engineers have developed the knowledge and created tools to remove, insert and delete bits of code from the genomes of living organisms in order to alter our biology. Reality engineering, Seife argues, is knowing how to insert bits and pieces into our reality and delete them as well, in order to alter our sense of reality. Reality becomes artificial; our "real" world can be manipulated and changed by the will of those who control the social networks that consume our attention, our time and our contact with one another (ibid.).

Intentionally or naively, the definition of learning presented by Downes in his 2012 ebook, *Connectivism and Connective Knowledge: Essays on meaning and learning networks,* eerily suggests reality engineering: "Learning is the creation and removal of connections between the entities, or the adjustment of the strengths of those connections. A learning theory is, literally, a theory describing how these connections are created or adjusted" (Downes, 2012c).

George Siemens has also argued for the need to trust in technology, off-loading the internal act of cognition and filtering to a computer network.

> While still in early stages of development, technology is permitting new ways of seeing information and the impact of interactions. As discussed earlier, rapid knowledge growth requires off-loading the internal act of cognition, sense and meaning making, and filtering to a network consisting of human and technology nodes.
>
> As a simple example, the popular tag feature of many sites (del.icio.us, digg.com, flickr) enable pattern recognition that captures the activities of thousands or millions of individuals.

> As knowledge complexifies, patterns—not individual elements—become of greatest importance in gaining understanding. (Siemens, 2006)

Reality engineering is very troubling because it represents a totalitarian state of reality—whereby one's personal, social, economic and political world becomes totally controlled and shaped by external forces. These forces have the power to *create, remove and adjust* what we experience and understand. This may not be where Stephen Downes or George Siemens intended to lead, but given their lack of research and the lack of debate and feedback on their ideas or practice, this is where they have landed.

> It used to take the entire resources of a totalitarian state—one that controlled the media, one that had absolute control of the information consumed by its citizens—to construct an alternate reality for its population. Now, thanks to the new tools at our disposal, a single person can do it on a small scale. Big organizations are learning how to do it in a deliberate and systematic way. The digital revolution has dramatically changed not just how we gather information about the world but also how we can tamper with the information others are gathering. (Seife, 2014, p. 5)

Moreover, our views of the world are altering and being altered. Humans are social animals and genetically predisposed towards collective knowledge and betterment. Digital media, controlled by a handful of owners, are reshaping how we view one another and how we act towards one another. News media are controlled by a few and journalists are being replaced by robots, "bots." Facebook news articles are often "written" entirely by AI bots; the new publishing model is becoming the McNuggetization of news, seeming to prefer cheap, entertaining and superficial over contemplative and meaningful.

These technologies are not necessarily neutral; they especially should *not* be trusted and lauded as replacements for human teachers and instructors in the manner advocated by connectivist founders, Siemens and Downes. Teachers and students must become very wary of subservience to technology. Commercial digital technology companies such as Google, Apple, Facebook, Microsoft and Amazon seek to control the medium and the message for their own profit and power.

The essence of technology is not solely technical, but also social, economic, political, cultural and cognitive. Writers on the subject, such as Silverman, caution that technology is not neutral, "a tool that can be put toward good or bad uses as so many techno-utopians are fond of claiming."

> Digital technologies have certain capacities built into them … the GPS chip can help you find a local restaurant; it can also be used to track all of your movements. Email … was private until Gmail and the National Security Agency (NSA) got their hands on it. Facial recognition offers few obvious benefits and is, by design, inclined to serve the needs of advertisers, intelligence agencies, security contractors, and other potentially untrustworthy actors.
>
> It would also serve us well to put some human agency back into the narrative. (Silverman, 2015, xii)

The owners of these powerful technologies have commercial and political aspirations. Silverman notes:

> Through the mountains of data these companies are collecting, they have come to believe that they know us. (Google's Eric Schmidt: "We know where you are, we know what you like.") It's only a small step, then, for them to decide that they know what's best for us. (2015, p. 6)

In fact, our apps already tell us what to do. They tell or suggest options of where to shop, what to buy, where to eat, etc. The app Google Now actively monitors and records your location while providing recommendations for nearby commerce. Silverman notes that the magazine *Popular Science*, which identified Google Now as the "product innovation of the year," declared: "Instead of telling your phone what you want, the phone tells you." (2015, p. 7). This is very much suggested in the Google 2014 slogan: "Google answers before you ask."

Proponents of connectivism advocate that this same technology should also tell you what to learn and, therefore, what to think. Connectivism reaches beyond the concept of teaching machines to propound and promote the role of "thinking machines." The technology will tell you the right answer, the best solution, how and what to think.

MOOCs represent a similar threat because the transmission model of education does not offer students the opportunity to question, challenge or disagree with the course content. MOOCs reflect a clear objectivist epistemology: whatever comes out of the course pipeline is to be accepted as the truth by the students. There are no human teachers, tutors, mentors or assistants to discuss alternative views. The auto-graded quiz is the guardian of the right answer: a student either provides the correct answer or is judged wrong. There are no grey areas. It suggests a highly totalitarian environment.

Moreover, in massive for-profit online courses with tens or hundreds of thousands of participants, who does one trust? Who can one trust? The only "authority" available is the AI.

Frank Pasquale, in his 2015 book, *The Black Box Society: The Secret Algorithms that Control Money and Information*, argues that social media and social networks are increasingly controlling our access to information and how we understand and connect with our world. Where *connectivist* theory and pedagogy argue for increased technological control over our connections with the world, social analysts and researchers counsel increased caution and concern. Pasquale writes:

> The more we rely on search engines and social networks to find what we want and need, the more influence they wield. The power to include, exclude, and rank is the power to ensure that certain public impressions become permanent, while others remain fleeting. How does Amazon decide which books to prioritize in searches? How does it ferret out fake or purchased reviews? Why do Facebook and Twitter highlight some political stories or sources at the expense of others? Although internet giants say their algorithms are scientific and neutral, it is very difficult to verify those claims. (2015, p. 14)

Network technology today is based on digitized media or AI:

1. AI collects vast reams of data on every individual using an online device, including computers, cell phones, notepads, iPads, etc.
2. This information is being continually collected and sold to third company advertisers who want to control and increase consumption patterns and commerce.
3. All information, even the most private – increasingly including the emotional and physiological states of every user of any digital appliance – is also being continuously collected by governments, the police and market forces.
4. This information is also being used to create machines that learn and that can lead to "human-level AI."
5. Human behavior online provides a vast fount of data used to understand, replicate and manipulate human activity. We are being used to mold our robot replacements.

In late 2015, in a startling reversal of his earlier work, Siemens recanted his support for edtech. On his *elearnspace.ca* blog, Siemens wrote: "Adios Ed Tech. Hola something else." He called this his "good-bye" to both edtech and to the "tool-fetish of edtech."

> I no longer want to be affiliated with the tool-fetish of edtech. It's time to say adios to technosolutionism that recreates people as agents within a programmed infrastructure. (Siemens, 2015b)

Siemens identified two events that triggered his decision to reject edtech.

> Two articles this past week crystallized my thinking. First, Sebastian Thrun, in an *Economist* article, states: "BECAUSE of the increased efficiency of machines, it is getting harder and harder for a human to make a productive contribution to society." If that is true, why is his startup trying to teach humans? Why not drop the human teaching thing altogether and just develop algorithms for making the stated productive contribution to society? He also details nanodegrees which are essentially what we in academia have to date called "certificates." Perhaps we can call them nano-robo-certificates …
>
> The second article focused on Knewton. Jose Fereirra states "this robot tutor can essentially read your mind." … Robot tutors will not make personalized learning easy. Learning is contextual, social, and involves whole person dynamics. In the past, I've stated that Knewton is the only edtech company with Google like potential. That is likely still the case, but I'm no longer convinced that this is a good thing. (ibid.)

Technosolutionism, Siemens argues, recreates people as agents within a programmed infrastructure. In essence, technosolutionism approaches human learning in the same manner as it would program a machine, with the pre-designated code simply imprinted on the human brain.

> Both Udacity and Knewton require the human, the learner to become a technology, to become a component within their well-architected software system. Sit and click. Sit and click. So much of learning involves decision making, developing meta-cognitive skills, exploring, finding passion, taking peripheral paths. Automation treats the person as an object to which things are done. There is no reason to think, no reason to go through the valuable confusion process of learning, no need to be a human. Simply consume. Simply consume. Click and be knowledgeable. (ibid.)

Overall, Siemens concludes: "*educational technology is not becoming more human; it is making the human a technology*" (ibid., emphasis added).

Summary

Chapter 6 examined the concept of connectivism and whether or not it meets the criteria of a bona fide learning theory. With its emphasis on a lack of course structure, promotion of network-organization, its efforts to diminish or eliminate the role of the instructor and its focus on learning that "occurs outside of a person," the concept remains ill-defined, ambiguous, contradictory and ill-advised. Connectivism was propounded as a theory of learning for the digital age without empirical or practical evidence and no evidence has subsequently been reported to confirm this proposition. Connectivism went beyond the notion of teaching machines by suggesting the use of thinking machines to replace teachers.

What distinguishes a learning theory, as discussed in Chapter 1, is that it answers questions such as "why," "how," "when," "where" and "what" kind of learning occurred under which circumstances? A theory explains how and why something occurred, a scientific explanation which means that we can study and understand learning by using the theory as a lens or framework for our observations. The theory that we employ determines what we see, what we consider to be important and how we design our practice. Learning theory also shapes how we envision the future of teaching and learning. The view propounded by connectivism carries a very negative message on the role and importance of teachers: connectivism promotes a need, not for new pedagogical models, but a full-scale replacement of live teachers and instructors by intelligent networks.

There have yet to be significant academic contributions to the field of knowledge by other researchers, so while "connectivist" courses known as MOOCs continue to gain traction, particularly by for-profit institutes, academic and anecdotal feedback remains mixed at best, with high drop-out rates and students lost within a sea of information.

The defining role handed to AI in the "connectivist" model, if we can call it that, raises ethical questions. While its proponents have advocated that corporate-designed AI be given control and supremacy over human learning and intelligence, one of the initial creators, George Siemens, has since denounced this approach as a dangerous attempt to treat and educate humans as robots.

Where connectivism focused on new technology to replace teachers, Chapter 7 introduces collaborativist theory, pedagogy and technology of learning, emphasizing the role of teachers to augment, not automate, human intelligence.

7
Collaborativist (aka Online Collaborative Learning) Theory

Education is not the learning of facts, but training of the mind to think.

—Albert Einstein

Chapter 7 introduces collaborativism and explores:

- Challenges and opportunities for online teaching and learning today
- Context of collaborativism
- History and roots of collaborativism
- Definitions of online learning
  - Collaborativism (aka Online Collaborative Learning or OCL)
  - Online distance education (ODE)
  - Online courseware (OC)
- Online collaborative learning (OCL) theory
  - The role of discourse and collaboration in learning and knowledge building
  - The three processes that comprise collaborativism or OCL
    1. Idea Generating
    2. Idea Organizing
    3. Intellectual Convergence
- Collaborativist or OCL pedagogy
  - Implementing the three collaborativist processes into pedagogy
  - The role of the instructor in collaborativist pedagogy
  - The role of the learner in collaborativist pedagogy

- Collaborativist or OCL technology
  - Collaborativist environments and their discourse attributes today
    1. Place-independent discourse
    2. Time-independent (asynchronous) discourse
    3. Many-to-many discourse
    4. Text-based discourse
    5. Internet-mediated discourse
- Attributes of online education environments tomorrow
  - Augmented human intelligence (AHI) versus artificial intelligence (AI)
  - Collaborativism and AHI
- Call to action for educators.

Introduction

Chapter 7 introduces the theory of collaborativism, previously known as online collaborative learning (OCL). Collaborativist theory represents a focus on learning networks that emerged with the advent of computer networking.

Computer scientists and engineers created the basic infrastructure of computer networks in 1969; email was invented in 1971 and computer conferencing in 1972. Almost immediately, educational explorations and applications followed. Online communication was totally new and unprecedented. Academics explored ways to enhance personal and social communication via computer networking, and thus contributed to transforming computer communications from networks initially designed for file transfer into environments that supported creative communication and collaboration among faculty and students. These developments set the stage for connected classrooms and courses offered entirely online, with students collaborating asynchronously in seminars, discussions and group projects.

The founders of online education reformulated classroom pedagogies or increasingly invented new pedagogies to take advantage of computer networking capabilities, enabling learners to work together across boundaries of time and place and collaborate in innovative, problem-solving, knowledge sharing and critical thinking activities. Computer networking opened unprecedented opportunities to share multiple perspectives on issues, to encourage reflective and analytical thinking skills and to build deeper multidimensional and multidisciplinary responses and understanding that went well beyond an emphasis on one "correct" answer.

A theoretical framework to explain online learning was recognized as necessary to frame pedagogical developments, to clarify the roles of the teacher and the learner and to identify evaluation rubrics and methods that would support research into online teaching and learning. Learning had to be clearly defined to allow empirical observation and definition: What is learning? What does it look like online? How can we identify it? What are the processes that comprise learning? Once we had identified the basic activities and processes that comprise learning, we could then develop pedagogies, assessment procedures and research methodologies. This is what constitutes a learning theory.

Learning theory typically arises from inductive study—field research and observation—rather than deductive proclamation. Collaborativism, or online collaborative learning, evolved as a theory over more than three decades and represented an inductive approach to theory building. This required generating enough practical experience and evidence to suggest commonalities. Researchers and practitioners then identified patterns and common factors beginning with specific observations and measures which, through data analysis, demonstrated patterns and regularities that became generalized conclusions and theories.

The theory of collaborativism that emerged was based on over 30 years of research and practice and a vast body of data—descriptions, publications, research and anecdotes from online education, and especially from experiences with collaborative learning from the early 1980s. Even a partial list of published books reflects the significant lineage and history of the field of collaborativist online learning: Mason & Kaye, 1989; Harasim, 1990b; Kaye, 1992; Hiltz, 1994; Harasim et al., 1995; Roberts, 2004; Kamara, 2013; Bates, 2015b; Schalkwyk & D'Amato, 2015.

Inductive theory building, as reflected in the development of collaborativism, is represented in the flowchart below:

Observation of practice → Patterns discerned → Conclusions → Theory

As has been noted throughout this book, learning theories are dynamic in nature, growing and advancing with new information, experience, technology, socio-economic shifts and the ensuing debates and discussions that seek to make sense of the changes. Theories not only guide practice, they also explain why and how a particular practice will achieve learning.

The Challenge and Opportunities for Online Teaching and Learning Today

The invention of the internet and the subsequent emergence of a plethora of educational applications encouraged innovation but, at the same time, also underscored rather than dismissed the need for new strategic approaches informed by educational theory and research. While the internet offers enticing potential for increased student interaction and active learning, the challenge is to fully understand the potential opportunities, and effectively transform pedagogy to reflect that understanding.

As demonstrated in Chapter 6, *learning networks* and *learning connections* do not of themselves represent a new learning theory or practice. While the internet does introduce the potential for interaction and active networking, it is essential to demonstrate how that interaction leads to learning.

In 2004, George Siemens, the founder of connectivism, proclaimed it to be *the* learning theory for the digital age without engaging in the necessary rigors to demonstrate how learning is actualized. In early 2015, after a decade of effort in that domain, he declared that he was leaving the field because: "*educational technology is not becoming more human; it is making the human a technology*" (Siemens, 2015b, emphasis added). This is a serious charge and one that we will explore in more detail later in this chapter. Unfortunately, the lack of empirical data and substantive analysis of connectivist theory and practice, as discussed in Chapter 6, has left practitioners unable to draw many objective conclusions, with the field of learning theory weakened as a result.

This is an important lesson to keep in mind as we consider current learning theories and approaches. Reduced government spending and enormous investments of billions of dollars by internet-based moguls in the form, not of traditional charitable donations but of Limited Liability Corporations (LLCs) such as the Emerson Collective run by Laurene Powell Jobs (widow of Apple founder, Steven Jobs), eBay founder Pierre Omidyar and the Omidyar Network and, more recently, the US$45 billion investment by Facebook's Mark Zuckerberg and his wife, Priscilla Chan, aim to shape the future of online education (Saul, 2015).

Immense wealth invested in education by private foundations and LLCs, as well as for-profit enterprises, seek to change the focus from public education and the use of teachers to computerized education that functions without human teachers, controlled by artificial intelligence (AI) algorithms owned by corporations. The focus of the investment is targeted on massive open online courses (MOOCs), personalized learning environments and adaptive learning software, which replace the teacher with AI software. Flipped classrooms and blended education employ computer software and AI for a significant portion of the educational activity.

Where established philanthropies—such as the Eli and Edythe Broad Foundation, the Bill & Melinda Gates Foundation, and the Walton Family Foundation—aggressively pushed an agenda of change that featured charter school growth, business-style management and test-based accountability, the new moguls push computerized learning to reshape public education with technology.

The intent is to replace teachers with AI software that will make decisions based upon algorithms that are mysterious and unknown, designed and controlled by hi-tech corporations. Such trends should not be embraced blindly without a full understanding of the effects of this type of reliance on AI on the processes of learning, and on society as a whole. As an example, students affected by the decisions made by computers will have little or no recourse since there will be no teachers to supervise or control the processes.

We are witnessing an unprecedented commercial investment in technology, robotics, AI, machine learning and digital media with an increasing intrusion of technology into our social, cultural, professional, personal, educational and emotional lives. The question becomes: Will we allow technological developments to dictate human learning processes or will we take the lead by studying and formulating the best applications of technology (AI in particular) in developing learning processes that benefit humankind?

The current era marks a paradigmatic shift that can unfold in at least two distinct and profound ways that present enormous challenges for the future of education: to use AI to augment human intelligence, or to use AI to replace human intelligence. For the first time in human development we are challenged to understand, anticipate and *design* the role of technology for the future, and its impact on humanity. Our role is no longer merely that of a historical observer. We are charged with considering and planning for the future: one that will be shaped by either an objectivist or a constructivist perspective. As such, the future is ours to design or to forfeit.

Collaborativist theory emphasizes the augmentation of human agency and knowledge, rather than its reduction or replacement by artificial intelligence. The roots of Collaborativist theory and technology can be traced to innovations such as Vannevar Bush's 1945 vision of the memex, Douglas Engelbart's 1965's prototypes of the Augment System, Ted Nelson's 1960's hypertext, and Murray Turoff's 1972 EIES computer conferencing system. Collaborativism examines the use of the Internet for collaborative learning and knowledge creation by humans as the basis of the Knowledge Age (Harasim, 1990, pp. 40–1).

The power and potential of technology to facilitate and enhance human communication and collaboration have been key to the massive excitement about and adoption of the internet over the past four decades. According to the Pew Research Centre, in 2015 more than half (54%) of the world's population was using the internet, enabling communication through computer networks (Pew Research Center, 2016). This figure increased to 87% when Pew looked solely at the 11 most advanced economies. This increasing power of computer networks to facilitate human intellectual and social collaboration has enabled the 21st century to represent the "Knowledge Age" (Pew Research Center, 2016). Yet, at the same time, computer networks are enabling surveillance and control of individuals and society, creating the potential for a "Surveillance Age." The 2013 revelations of former US National Security Agency (NSA) whistleblower, Edward Snowden, indicate that much of this frightening potential has already been realized.

Collaborativism focuses on approaches and techniques that use the internet to facilitate collaborative learning and knowledge building as a means to reshape formal, non-formal and informal education for the Knowledge Age, and to do so in a manner that demonstrably enhances human learning. It recognizes and accommodates 21st-century Knowledge Age requirements and provides a theoretical framework to guide the necessary transformations in instructional design. Decades of research and practice from around the world indicate that collaborativism not only has the potential to enhance conventional classroom and distance education, but also to enable entirely new and better learning options. Collaborativist theory, its pedagogies and technologies are presented and explored in this chapter while Chapters 8 and 9 provide follow-up case examples and scenarios of collaborativism in practice.

Chapter 7 is composed of four main sections:

- *Context of Collaborativist Learning*: This section introduces the context, history and major definitions of online learning. The context argues that a 21st-century Knowledge Age requires learning activities that emphasize group discussion and knowledge creation using online communication technologies.
- *Collaborativist Theory* is presented as a theoretical framework to guide learning in the Knowledge Age. Key to collaborativism is group discourse that supports and advances Intellectual Convergence and knowledge construction activities. The collaborativist theoretical framework comprises three phases of discourse: Idea Generating, Idea Organizing and Intellectual Convergence.
- *Online Collaborativist Learning Pedagogy* discusses online pedagogies that can facilitate Intellectual Convergence and knowledge building in educational settings. The three phases of the OCL theoretical framework provide a guideline for curriculum design, implementation and assessment.
- *Online Collaborativist Learning Technology* introduces several collaborativist tools and collaborativist environments. Collaborativist technological environments are designed to explicitly support collaborative learning and knowledge-building discourse. Of special importance is the potential of computer mediation to either support augmented human intelligence or to negate human cognitive and manual labor by advancing AI.

Context of Collaborativism or Online Collaborative Learning (OCL)

What were then called online collaborative learning activities began in the early 1980s soon after the invention of computer communication, primarily email and computer conferencing. Since then, the field of online education has been characterized by an amazing array of educational activities, models and approaches that emphasize group discussion and group work. These activities have continued and grown at all levels of education—primary, secondary, tertiary and non-formal. The rapid growth of the practice, combined with active field research, has created a large base of empirical data from which patterns can be discerned.

New and expanding opportunities for extensive communication and collaboration among a diverse group of peers and instructors have been the major educational benefit of computer networking. Learning networks, online courses, electronic pen pals, online learning circles, computer-supported collaborative learning, knowledge forums, listservs, online seminars, computer-supported cooperative work, online communities and a host of other terms reflect the potential of computer communication to enable in-depth educational discourse. Discourse is defined here as human-to-human communication and interaction; it does not include computer-generated comments or responses from (semi-)sentient AI, such as Apple's Siri, Microsoft's Cortana, Amazon's Alexa and Google Assistant.

Social and educational reforms related to the civil rights, feminist and anti-war movements in the latter part of the 20th century contributed to a shifting emphasis towards more active, collaborative and democratic learning approaches. This context was linked to the constructivist epistemology in education, and constructivist perspectives and theory of learning (see Chapter 5). The result was to view learners as having rights, responsibilities and interests that should rightfully be acknowledged in the learning process.

Classroom practices were impacted by constructivist perspectives and learning theory; however, 20th-century educational researchers found constructivist learning theory to be inadequate in addressing the importance of conceptual change and knowledge building in the contemporary online environment. Scardamalia and Bereiter (2006, p. 98) note: "In light of this challenge, traditional educational practice—with its emphasis on knowledge transmission—as well as the newer constructivist methods both appear to be limited in scope if not entirely missing the point." Moreover, they point out:

> Ours is a knowledge-creating civilization. … Sustained knowledge advancement is seen as essential for social progress of all kinds and for the solution of societal problems. From this standpoint the fundamental task of education is to enculturate youth into this knowledge-creating civilization and to help them find a place in it. (ibid.)

The Knowledge Age requires and enables knowledge creation both as a process and a product: knowledge building is an essential socio-economic process and knowledge itself is a key and competitive product. Socio-economic transformations today emphasize processes of innovation over repetition, collaboration over individualistic approaches and the creation of knowledge over the simple transmission of information in how we work and, concomitantly, how we learn.

Knowledge products can be characterized as inventions and innovations; new ideas, solutions, tools and technologies, as well as new applications of these inventions in new ways of doing things and of doing new things. The current generation of youth has grown up collaborating using online technologies. Tapscott and Williams, authors of the 2006 book, *Wikinomics*: *How Mass Collaboration Changes Everything*, note that:

> This is the first generation to grow up in the digital age, and that makes them a force for collaboration … The vast majority of North American adolescents know how to use a computer, and almost 90 percent of teenagers in America say they use the Net. The same is true in a growing number of countries around the world. … This is the collaboration generation for one main reason: Unlike their parents in the United States, who watched twenty-four hours of television per week, these youngsters are growing up interacting. Rather than being passive recipients of mass consumer culture, the Net Gen spends time searching, reading, scrutinizing, authenticating, collaborating and organizing … (Tapscott & Williams, 2006, p. 47)

This is important because a key problem is "the serious and persistent gap between how the digital youth of today learn in school and how they interact and work outside of school" (IESD, 2009). Educators, meanwhile, are confounded and unsure of how to proceed. Many students are already adept at online group work before they reach the classroom, yet classroom work from school to university is not significantly predicated on online work or collaboration.

Traditional classroom work treats online activities as secondary to the "real" curriculum at the same time that youth are increasingly growing up in an online world. Most classwork and homework is individual. And here lies the paradox. Despite the rise of the internet in the real world, teachers are reluctant to integrate it into the educational world. National studies in the US have demonstrated that educator attitudes are critical of the growth of online learning program yet they are key to the acceptance of online learning theory and pedagogy (Allen & Seaman, 2008).

Teacher and faculty support is essential to effecting substantive educational transformation and adoption of online learning, but many teachers are resistant and faculty acceptance is a critical barrier to its widespread adoption (ibid.).

This book argues that the major conundrum is not necessarily resistance to change by educators, but the lack of a theory or strategy to assist teachers and guide the pedagogical transformations required. Teachers, trainers and faculty are being asked to change without guidance about the educational paradigmatic changes occurring, the implications of educational transformation and the ways in which teachers can develop and implement new pedagogies that are consonant with these realities.

This is where a contemporary theory of learning is critical. The educational challenge cannot be addressed until educators identify the learning theories and pedagogies that they believe best address the Knowledge Age realities so that they can confidently apply them in their classes.

And this is a wise decision … there are many challenges and risks to education and to society that are becoming evident along with the exponential growth of computing over the past two decades, and the astonishing growth and application of AI today.

Challenges and Risks

Rapid technological advancements pose major challenges and risks to education, including online education. Understanding learning theory is more critical than ever as the various theories of learning and their epistemological bases hold serious implications for education and society. Educators need to become cognizant of the theories and their implications, both within their classrooms and in discussing and shaping the future of education with colleagues, parents, decision-makers and technology providers. Key challenges and risks include the following:

1. LACK OF PUBLIC UNDERSTANDING OF ONLINE EDUCATION

Overall, online education is not yet well understood by the public, media and politicians or even by the teaching profession. Perhaps the greatest problem is the general lack of appreciation and understanding of its value and its potential to create a future based on enlightened principles of social well-being, civil society and equitable global advancement.

As discussed in Chapter 6, the risk of humans being replaced by AI, or being trivialized into automatons who simply click on a "right" answer rather than thinking about the "best" solution is becoming increasingly real. And this risk is double-edged for educational professionals who face not only the specter of mass layoffs, but of potentially watching the dumbing down of future generations of students.

2. OVER-EMPHASIS ON TECHNOLOGY

The major myth or misunderstanding being propagated today is that educational access and quality is primarily an issue of technology rather than pedagogy. This perspective is rooted in specific theories of learning. As this book has discussed, theories associated with behaviorism, cognitivism and connectivism promote technology over pedagogy as the solution to educational progress, arguing that efficiency and mass application are more important than effectiveness and depth of understanding. Technology is viewed as superior to pedagogy. Currently, success is defined as quantitative: that is, emphasizing more efficient transmission of content through better technology to massive numbers of students. Technologies associated with these learning theories also promote individualist pedagogies and approaches that replace the teacher. Machines and technologies are more efficient at transmitting information: machines work without stop; quantity of instruction becomes emphasized over quality; massive transmission is valued over effective learning and understanding. The media message is the superiority of technology over teachers.

3. EDUCATION PROFESSIONALS ARE ON THE ENDANGERED LIST

A surprising undercurrent today is the shift in public understanding and appreciation of what makes teaching a profession, at the same time as the profession is undergoing huge challenges from for-profit forces, as well as disruption by the for-profit "sharing economy."

a) Public awareness of online education was triggered in 2012 by the American media portrayal of MOOCs as the educational revolution that would save the world. The hype was that online transmission of content to massive numbers of people would "unlock a billion more brains": technology would replace human teachers. Stephan Popenici, an academic with extensive international education experience, addressed the shallow but intoxicating myth of the MOOC:

> The solution to deliver good quality higher learning to all enlightened the imagination of many. The narrative was fantastic: the door to what *Time* called "High-End Learning on the Cheap" was discovered and new startups and venture capitalists were there to fight to open it for the benefit of the poor around the world. Thomas Friedman argued in 2012 that "nothing has more potential to lift more people out of poverty" than Silicon Valley solutions and MOOCs will "unlock a billion more brains to solve the world's biggest problems." (Popenici, 2014)

b) A different challenge to educational professionals is coming from sources such as Udemy, a company that enables anyone to teach online and charge for it. People with particular skills or no skills at all can create courses, market them and even provide a certificate based solely on their own claim of knowledge. These people have been referred to as "anti-professors" or "renegade professors." They create video lectures in their own homes on any of a vast array of topics, some of which may be academic in nature, others that are skill-based, and sell them on Udemy or other similar sites. As a result, the line between skills acquisition and education is blurring. Such ventures in online education are being compared to the disruption by Uber in the taxi business, or of Airbnb to the hotel industry.

Jeffrey Young, senior editor of *The Chronicle of Higher Education*, examined what happens when what he calls the "sharing economy" meets higher education (Young, 2015). Young notes that what used to be taken for granted about the profession of teaching and of academe is losing its power. Education as a profession is being devalued, given the options that are flooding in with network technologies and video lectures. The greatest challenge, Young concludes, may be that: "These sites that let anyone teach courses might just change the way people think about the value of education, about the nature of expertise, and about what teaching is worth" (ibid.)

4. TEACHERS UNDERESTIMATE THE IMPORTANCE OF EPISTEMOLOGY + THEORY

The challenge to educational professionalism can be related to teachers' own lack of appreciation and understanding of the importance of epistemology and theory in their practice. Too often, teachers are not made aware of the concept of epistemology and how it articulates one's view of learning. Few teachers or professors today can provide a definition of learning and how they actualize that definition in their teaching. This is not because teachers are incompetent but because the basic issue of theory has not been emphasized in educator training and consideration.

Teacher education must educate students about the two major epistemologies and their implications for education and society:

- *Objectivist Epistemology* is reflected in didactic teaching methods such as lectures and quizzes, which present the view that there is a correct answer, a truth that exists externally and that technology can better and more efficiently present this truth instructionally. This view has been linked with efforts over time to replace human educators with technology: examples include the 1926 Pressey teaching machine, computer-assisted learning, and the advent of artificial intelligence (AI) used in expert tutoring systems, MOOCs, personal learning environments (PLEs), and adaptive learning systems (ALS).
- *Constructivist epistemology* views knowledge as the result of human discourse: conversation, collaboration and debate. This perspective views discourse as the basis of human learning: humans create, share ideas and knowledge in order to survive and thrive. Technology, in this perspective, mediates and enhances but does not control or replace human interaction. The collaborativist approach exemplifies constructivist epistemology.

5. ONLINE EDUCATION HAS A SIGNIFICANT HISTORY OF RESEARCH TO INFORM TODAY'S PRACTICE

Online education has been shaped and informed by over 30 years of practice, scholarship, research and development. This history is key to understanding the field, the different approaches to online education and the most effective pedagogical designs and practice. MOOC providers and developers, however, did not acknowledge or perhaps they were not aware of the discipline of online education before they stormed the walls. Nor have they demonstrated knowledge of any lessons learned from online education research. MOOC companies act as though they have discovered the secret to learning but the poor results demonstrate a lack of knowledge of the field and the processes of learning.

6. UNDER-FUNDED CLASSROOMS AND IMMENSE INVESTMENT BY THE INTERNET MOGULS

In today's under-funded public education system (public and private schools and universities), companies such as Google, Facebook, Amazon, Apple and Microsoft, as well as smaller educational technology companies, are actively involved in shaping educational policy and pedagogy decisions while replacing teachers with their proprietary AI-controlled technology such as MOOCs, personalized learning environments and adaptive learning systems. These instructional systems are controlled by algorithms (advanced decision-making software) owned by these corporations. Neither the public nor professional educators will be able to easily intervene to question or to understand, much less challenge, redesign or reject the totally automated black box that will be "educating" future generations.

7. HOW THEORY CAN HELP EDUCATIONAL PROFESSIONALS: THE NEED FOR A NEW LEARNING THEORY

Educators, professors and teachers need to understand the different learning theories that frame online educational practice to meet these new challenges in education and to inform themselves and the world (the stakeholders) about the serious opportunities, trade-offs and threats that are gathering at the gates. The ability to understand and to speak about the implications of different learning technologies, pedagogies, epistemologies and theories is key to emphasizing the valuable role of the educational professional.

Collaborativist theory introduces an important framework and mindset. Whereas the Industrial Revolution extended and leveraged our physical capabilities to manipulate objects far beyond muscle power alone, the internet revolution has the potential to emphasize, extend and leverage our mental capabilities.

Whereas learning theories and pedagogies of the 20th-century Industrial Age focused on narrow, individualistic tasks with simple rules and clear destinations, the 21st-century Knowledge Age, has enabled creative conceptual work where there is no clear right or wrong answer, or where there may be many right answers, requiring knowledge workers to collaborate to identify or create the best options.

The knowledge worker in today's era needs to develop analytical thinking skills. It is the role of the teacher to facilitate this and to acculturate the student to the field. The teacher acts to mediate between the learners and the knowledge community, to increasingly bridge the gap until the learner becomes familiar with and part of the discipline and can *talk the talk*, and *walk the talk* (to discuss and analyze the knowledge problem, and to apply the results to resolving the problem).

Educational designs and pedagogies based on new theories such as collaborativism provide a basis for addressing these Knowledge Age realities that educators can apply in their work. We begin by considering the roots of collaborativism in the next section.

The History and Roots of Collaborativism or Online Collaborative Learning (OCL)

The invention of online education came at a time of great intellectual exploration and rapid technological change, with a wealthy post-war economy in the US. The invention of the computer in the 1950s, and computer networking in the 1960s, triggered new visions about ways to collaborate to build knowledge and to work. One of the great inventors of the time, Douglas Engelbart, is the inventor of the computer mouse, windows, word processing, point-and-click, and collaborative computing—all in the 1960s. Engelbart's induction into the Internet Hall of Fame in 2014 acknowledged that his greatest contribution to society was not only technological. Engelbart was hailed primarily for his intellectual vision and contribution to how humans collaborate. This internet pioneer's greatest achievement may have been to change how we think, how we learn and innovate and how we collaborate (Internet Hall of Fame, 2015).

In October 1962, Engelbart published his foundational paper, "Augmenting Human Intellect: A Conceptual Framework." Engelbart had begun to conceptualize how computers—then still huge mammoths the size of a room—could be used to create, access and share ideas and information. He was inspired by a 1945 article by Vannevar Bush which called for "a new relationship between thinking man and the sum of our knowledge," a kind of automated collective memory he dubbed the "Memex." Engelbart built on these concepts to create a framework for what he came to call "collective IQ." Collective IQ sought to improve how we collaboratively develop, integrate and apply knowledge (Engelbart, 1962).

Around the early 1970s several efforts to develop group communication environments based on computer conferencing emerged. Murray Turoff invented the EIES computer conferencing system for online group communication in 1972. In 1976, Turoff, together with Starr Roxanne Hiltz, published *Network Nation*, a book that inspired many with the possibilities of group collaboration online. Computer conferencing systems became the technology that triggered the invention of online collaborative credit courses. Turoff and Hiltz went on to become highly recognized pioneers of online learning.

Computer conferencing systems, designed to facilitate group discussion, became the first technology for online credit courses and learning networks because, at the most basic level, conferencing systems (also known as forums) enabled group discussion across time and space over computer networks.

The first online credit course delivered entirely via the internet was taught in January 1986 at the University of Toronto, through the graduate school of education (OISE: the Ontario Institute for Studies in Education). The topic was "Women and Computers in Education."

Ironically, while the course addressed the lack of interest by female students and women teachers in educational computing, the online course became very popular with both female and male students. Female education students were attracted by the topic, but also by the pedagogy of online collaboration and group discussion. Interestingly, in 2015, Pew research reported that girls dominate social media communication sites, whereas boys are more like to play video games (Lenhart, 2015).

This first online course was designed and taught Dr. Linda Harasim and Dr. Dorothy Smith (Harasim & Smith, 1986, 1994). In this course, a collaborativist pedagogy was developed that has since been adopted and adapted in a variety of online post-secondary courses as well as in online training and in professional development activities.

Online collaborative learning was an immense challenge to conceptualize and implement given an unprecedented environment characterized by asynchronous, text-based, place-independent, many-to-many communication. This was an entirely new experience for the learners and the instructors. The graduate course was 13 weeks long and took place entirely online, using a computer conferencing system. Each week, new conferences were opened (or closed) by the instructors; some conferences supported plenary discussions (to create a sense of community among students who would be working "together" at different times, from different places). Later, we introduced conference spaces to support projects by learning dyads to encourage learning partnerships and friendships; other online collaborative learning designs that were invented at this time were group projects, debates and seminars.

A significant challenge from the outset was how to coordinate collaborative learning online, given that participants were not working together in the same place or at the same time. Online collaboration represented uncharted territory, and its application in education—where timing and coordination are essential—was a complex challenge. In 1986 I developed the concept of the "online week," which served as the temporal unit to coordinate activities in this asynchronous environment, and have successfully used this approach ever since.

These efforts were what was then called online collaborative learning (OCL) in its earliest articulation—now renamed collaborativism. The opportunity for time- and place-independent group discussion proved to be a powerful catalyst for envisioning dialogue and debate unfettered by access constraints.

Later in a totally separate initiative during 1986–1987, Roxanne Hiltz launched field trials of online education with undergraduate students at the New Jersey Institute of Technology. The project and the software that was developed to customize computer conferencing for education was called the Virtual Classroom (Hiltz, 1994).

Online education in the 1980s was viewed (if at all) as an educational outsider, certainly not a contender for status quo or mainstream acceptance. By the early to mid-1990s, the scene began to change as the public release of the internet increased access. As a result, the late 1990s represented a dramatic shift in public recognition and perception of online education and it gradually came to be viewed as valid and beneficial, and increasingly accepted as mainstream.

The shift toward increasing acceptance and adoption of online education has been documented in a series of public reports initially sponsored by the Alfred P. Sloan Foundation. These reports served as significant barometers of the growth and acceptance of online education in the US. The first report, *Sizing the Opportunity: The Quality and Extent of Online Education in the United States, 2002 and 2003* (Allen & Seaman, 2003), examined the importance of online education at more than 1,000 universities in the US. The survey revealed that students were clearly willing to sign up for online courses: over 1.6 million students (11% of all US higher education students) took at least one online course during the fall of 2002. This report marked the beginning of a sea change in the acceptance of online learning. Within a decade, attitudes toward online education had shifted; the recognition of online education by academic leaders went from negligible in the early 1990s to acknowledging it as a field with important potential by 2002.

Since the first online university course in 1986, online courses have grown from marginal to mainstream. The proportion of academic leaders who reported that online learning is critical to their institution's long-term strategy grew from 48.8% in 2002 to 70.8% in 2014 according to the 2014 Survey of Online Learning conducted by the Babson Survey Research Group (Allen & Seaman, 2015). The 2014 survey found that over 37% of higher education students in the US had taken at least one online education course and that the rate of increase in over a decade of online enrollment far exceeded that of overall higher education.

Online learning has become mainstreamed, recognized and valued by the public and has been adopted by educators around the world. Moreover, studies are increasingly reporting empirical benefits of online learning. A 2009 report on online education prepared for the US Department of Education concluded that: "On average, students in online learning conditions performed better than those receiving face-to-face instruction" (Means, Toyama, Murphy, Bakia, & Jones, 2009). The report examined comparative studies of online versus face-to-face classroom teaching from 1996 to 2008, some of which was conducted in K–12 settings but also in colleges and adult continuing education programs, such as medical training and the military. The report was a meta-analysis of 99 studies that had conducted quantitative comparisons of online and classroom performance for the same courses. The report for the Department of Education found that, on average, students doing some or all of the course online ranked higher than the average classroom student. Barbara Means, the study's lead author and an educational psychologist at Stanford Research Institute (SRI), was quoted in the *New York Times*: "The study's major significance lies in demonstrating that online learning today is not just better than nothing—it actually tends to be better than conventional instruction" (Lohr, 2009).

The report provides powerful evidence of the value of learning online. However, the report was not able to link results with pedagogical approaches since most research studies did not include pedagogical information. The results arguably point to the promise of online learning, and demonstrate that this potential can be met. The challenge is that it is not yet clear how best to realize the potential.

Despite the growing support for online learning, online education has been poorly defined and theorized, with little explication of which pedagogies, approaches, tools and environments should be used, under which conditions, to achieve the best results.

This lack of a clear definition of learning theories and pedagogies may explain why the most common concern cited by the Sloan studies thus far has related to low levels of faculty acceptance (Allen & Seaman, 2007). Often teachers do not have the necessary tools, training or understanding to fully embrace online education. They need the necessary resources and training along with guidelines framed by theory.

Definitions of Online Learning

Currently, at least three different models of education are offered online; these models are not only contradictory, they are antithetical (opposed to one another). It is important that the different learning models are identified according to their theoretical and epistemological position. Different online learning models lead to very different rates of drop-out, user satisfaction and skills in analytical thinking and active learning. Understanding the underlying theoretical frameworks behind each model guides educators to better understand research results, to design better pedagogical approaches and to develop or choose the most appropriate technologies to implement effective online courses and activities.

The three distinct online learning models are: collaborativism aka online collaborative learning (OCL), online distance education (ODE) and online courseware (OC) (Harasim, 2002). These three approaches *each* use the internet for education, but in significantly different ways and with major differences in learning theory, learning pedagogies and learning technologies. Collaborativism, for example, places significant attention on the role of the teacher with emphasis on student discourse and collaboration; ODE uses a correspondence model of course delivery, self-study and individual communication with a tutor; and OC (including MOOCs) is based on individualized learning controlled by computer programs, increasingly using AI, without instructor or peer interaction. These three approaches are described in more detail below.

Collaborativism (aka Online Collaborative Learning or OCL)

Collaborativism refers to educational applications that emphasize collaborative discourse and knowledge work mediated by the internet; learners work together online to identify and advance issues of understanding, and apply their new understanding and analytical terms and tools to solving problems, constructing plans or developing explanations. Collaborativism emphasizes processes that lead to both conceptual understanding and knowledge products. It is based on peer discourse that is informed by the processes and resources of the knowledge community and facilitated by the instructor as a representative of that knowledge community. Most commonly, the discourse is text-based and asynchronous, taking place in a web-based discussion forum or computer conferencing system.

The role of the instructor is key: the teacher structures the course as a series of group discussions focused on knowledge problems common to the discipline, introduces appropriate concepts and resources to facilitate informed debate, encourages and models the analytical language that represents the discipline, intervenes to facilitate the discussion and assists students in reaching a level of Intellectual Convergence to analyze or solve the problem. The teacher is not merely a facilitator of the group discourse but represents the "science" of the knowledge community, and serves to induct the learners into the discipline. The course models the behavior and processes of the knowledge community in addressing knowledge problems.

Online Distance Education (ODE)

The ODE approach reflects the cognitivist learning theory and pedagogies based on self-study and individualized learning modules discussed in Chapter 4. ODE is primarily based on traditional 19th- and 20th-century correspondence education models, but replaces postal-mail delivery with cheaper, faster and more efficient email delivery of course materials and tutor feedback.

As early as 1997, Romiszowski and Ravitz (1997, pp. 755–756) emphasized that the use of online communication by distance education providers had been based on the "instructional technology" model, rather than what they called the collaborative "conversational" model. They highlighted the value of the "conversational" paradigm (which we can identify as collaborativism) over the "instructional" paradigm (termed here as OC).

In recent years, many institutions have combined ODE with collaborativist pedagogies in their course design, thereby moving toward a blended pedagogical model (ODE + collaborativism). This shift to increasingly incorporate collaborativist pedagogy moves online learning into a more conversationalist paradigm. A significant component of the course becomes the group discourse, while the instructional aspect is an informational self-study component. The "flipped" classroom is another example.

Online Courseware (OC)

OC refers to the use of courseware (pre-packaged content) that a learner accesses online or receives via email. OC (and MOOCs) employ an individualized, self-paced pedagogy; the learner interacts with the courseware content, typically a video lecture, which is presented in a modular format. Upon completion of each 8- to 10-minute module, the student takes a post-test (a multiple-choice quiz that is computer graded) to "assess" his or her understanding of the content, and to provide remedial action if the student fails the post-test.

OC is an example of instructional technology based on cognitivist learning theory (discussed in Chapter 4). It is based on a prescriptive model of instructional design emphasizing individualized learning pedagogies. There is no discourse among peers, or with a tutor or instructor. OC is most commonly employed in the training sector, where it represents a major investment by large corporations, governments and the military.

MOOCs are a variant of courseware—using a similar pedagogy of *Content + Quiz*—that have targeted university and high school education and gained a high degree of media and public attention, despite very poor educational outcomes (see Chapter 6).

Table 7.1 outlines the basic characteristics of each type or category of online learning that has been discussed in the previous sections. It highlights the distinctive as well as common characteristics.

Having briefly introduced and distinguished the three major categories within the umbrella term "online education," the remainder of the chapter discusses collaborativist theory, pedagogy and technologies.

Collaborativism aka Online Collaborative Learning Theory

Collaborativist theory provides a model of learning in which students are encouraged and supported to work together to learn and to create knowledge. Collaborativist theory defines learning as Intellectual Convergence.

Techniques such as "active learning" or "learning by doing" imply that student interest-driven activities will generate knowledge and skill. In the active learning model, the role of the teacher is not defined, and is often diminished to simple participation, with no distinct value added. Nonetheless, collaborativism builds on constructivist learning theory by exploring and emphasizing the role of discourse as theorized by Lev Vygotsky.

The Role of Discourse and Collaboration in Learning

Collaborativism emphasizes the key role played by discourse in knowledge creation, sharing, dissemination, application and critique. Discourse refers to written or spoken discussion and conversation. It is also posited as the catalyst for the development of civilization, and the basis of thought and knowledge.

TABLE 7.1 Three Types of Online Learning

Collaborativism or Online Collaborative Learning (OCL)	*Online Distance Education (ODE)*	*Online Courseware (OC)*
• Online discourse	• Online delivery	• Online content+quiz
• Group learning	• Individual learning	• Individualized learning
• Instructor led	• Tutor support	• Computer assessment
• Asynchronous	• Asynchronous	• Asynchronous
• Place independence	• Place independence	• Place independence
• Text-based discussion	• Text-based assignments	• Video-based lectures
• Internet-mediated discourse	• Internet-mediated delivery	• Internet-mediated presentation

Lev Vygotsky's 1962 book, *Thought and Language*, is recognized as a major contribution to understanding the role of language and society in human thought. Vygotsky makes the argument that thought is inner conversation with ourselves, a collaboration turned inward. "The relation between thought and word is a living process; thought is born through words. A word devoid of thought is a dead thing, and a thought unembodied in words remains a shadow" (Vygotsky, 1962, p. 153).

Vygotsky was an early and major force in advancing the importance of collaboration for knowledge construction; he revised learning theory by moving the unit of analysis from the individual per se, to the individual in relation to the environment, and to interaction with others. He defined learning as a social process, based on language, conversation and the "zone of proximal development" (ZPD), whereby we learn through contact and discourse with an adult or peer more competent in the field.

Kenneth Bruffee (1999) writes along the same lines: "We think because we can talk with one another" (p. 134). Knowledge is viewed as generated by speech and conversation with one another, a construct of the community's form of discourse, negotiated and maintained by local consensus and subject to endless conversation (Kuhn, 1970; Bruffee, 1999). "Education initiates us into conversation, and by virtue of that conversation initiates us into thought" (Bruffee, 1999, p. 133).

Collaboration and discourse are key to building knowledge, an endless human conversation of changing and improving ideas. Academic disciplines and commerce reflect the growing recognition of collaboration in human development. Anthropologists have come to view intentional collaboration as being at the very core of human identity and the essence of civilizational advancement (Hrdy, 2009). Invention and knowledge are perceived not as products of individual genius, but of knowledge communities and collaboration.

Michael Farrell (2001) argues that artists, like scientists, collaborate and share a common vision, a school of thought, by participating in "collaborative circles." Collaborative circles are:

> … a primary group consisting of peers who share similar occupational goals and who, through long periods of dialogue and collaboration negotiate a common vision that guides their work. The vision consists of a shared set of assumptions about their discipline, including

Figure 7.1 Examples of Online Discourse.

> what constitutes good work, how to work, what subjects are worth working on, and how to think about them. For a group of artists, the shared vision might be a new style. For a group of scientists, it might be a new theoretical paradigm. (p. 11)

Bruffee (1999) similarly emphasizes the importance of collaboration for knowledge construction. He cites the studies of Bruno Latour and Steve Woolgar, who concluded that:

> … scientists construct scientific knowledge through conversation, and that the most important kind of conversation scientists engage in is indirect, that is, displaced into writing. Scientists, they tell us, are "compulsive and almost manic writers." Conversation among scientists illustrates, furthermore, how we construct knowledge in every field and walk of life. (Bruffee, 1999, p. 53)

Collaborativist theory and pedagogy seek to initiate the learners into the processes of conversation (discourse) used by knowledge communities to create knowledge and improve ideas. As Bruffee has observed, discourse is the means of transitioning from one community of knowledgeable peers to the next as we become re-acculturated through engagement with each new community.

> From the very beginning of our lives we construct knowledge in conversation with other people. When we learn something new, we leave a community that justifies certain beliefs in certain ways with certain linguistic and paralinguistic systems, to join instead another community that justifies other beliefs in other ways with other systems. We leave one community of knowledgeable peers and join another. (ibid., p. 135)

Michael Tomasello, a world leader in cognitive anthropology and the distinguishing qualities of homo sapiens, writes:

> we cannot conceive any comprehensive theory of the origins of uniquely human thinking that is not fundamentally social in character. To be as clear as possible: we are not claiming that all aspects of human thinking are socially constituted, only the species-unique aspects. It is an empirical fact that the social interaction and organization of the great apes and humans are hugely different, with humans being much more cooperative in every way. (Tomasello, 2014, p. 153)

Tomasello has spent over 20 years studying how humans think and learn. His 2014 book, *A Natural History of Human Thinking*, covers the evolution of human cognitive development over the past million or so years, to present the argument that collaboration is key to human cognitive uniqueness. Like other members of the great ape family, early humans began as *social* beings who could *think* but at a primitive level. And like other great apes, early humans were individualistic and competitive. But humans, Tomasello argues, entered a second phase in which, given environmental factors, our earliest human ancestors had to enter into cooperative living structures, dependent on one another, and hence had to learn to think and communicate with collaborative partners. Tomasello (2014) calls this the "shared intentionality" hypothesis in which we collaborate in the work and in the rewards/risks. Early humans had to learn to see the world from multiple perspectives, in order to coordinate and understand their partners' perspectives—and in order to find partners who wished to collaborate with them.

> Great apes are all about cognition for competition. Human beings, in contrast, are all about (or mostly about) cooperation. Human social life is much more cooperatively organized than that of other primates, and so, it was these more complex forms of cooperative sociality that acted as the selective pressures that transformed great ape individual intentionality and thinking into *human shared intentionality and thinking.* (ibid., p. 31, emphasis added)

Tomasello's arguments about human thinking and collaboration are essential for educational consideration. We need to understand how humans think, cooperate and communicate if we want to facilitate learning. Early humans became essentially collaborative beings around 400,000 years ago (ibid., p. 48).

Intentional collaboration defines humankind. Shared intentionality and thinking abilities are the hallmarks of our evolution that distinguish us from other animals (including other great apes), and are key to how humans have survived and thrived over the past half million years.

Collaborative learning recognizes discourse as the foundation of human learning and refers to ways of teaching and learning based on discourse whereby students co-labor to produce a result whether to solve a problem, discuss or improve an idea, explore a hypothesis or undertake a project (Harasim, 2004).

Unlike "cooperative learning" in which each group member contributes an independent piece to the whole in the form of a division of labor, with collaborative learning the group members discuss and work together throughout the process. The *process* itself is collaborative, not just the product. The process is one of conceptual change, in which learners in a shared context (a course, a seminar or a discussion) engage in a process of progressing from divergent to convergent perspectives and understanding. With facilitation, intellectual divergence such as individual brainstorming, disagreeing or debating, eventually leads to a consideration of new ideas and exploration of the merits of the different perspectives generated by the others in the group.

Discussing, debating, accessing new sources of information and learning analytical concepts moves the group from an initial position of brainstorming to more considered analysis of various perspectives, linking common ideas and filtering out the weaker ideas. Eventually, the group arrives at a position of Intellectual Convergence that reflects a deeper understanding of the content area and also of the process of knowledge building. Potentially it might even contribute to the practice or to advancing the state-of-the-art.

The primary role of discourse in knowledge communities is not merely to persuade but to generate progress toward the solution of shared problems. Scardamalia and Bereiter (2006, p. 100) propose the following criteria for knowledge-building discourse in an educational context:

- a commitment to *progress*, something that does not characterize dinner party conversation or discussions devoted to sharing information and venting opinions;
- a commitment to *seek common understanding* rather than merely agreement, which is not characteristic of political and policy discourse, for instance;
- a commitment to *expand the base of accepted facts*, whereas, in court trials and debates, attacking the factual claims of opponents is common.

The Three Processes that Comprise Collaborativism (aka OCL)

Collaborativist learning theory is based on three key learning processes or stages that lead from divergent thinking to Intellectual Convergence. Divergent thinking refers to a process that generates many questions, ideas, responses or solutions. It is associated with brainstorming and creative thought, and draws on ideas from different perspectives and many sources (including personal observations and experiences).

While divergent thinking involves generating many ideas, the process associated with identifying the best ideas and discarding the weak ones is known as convergent thinking. Convergent thinking refers to narrowing down the options based on existing information and analysis, and selecting the best. Linus Pauling, the great scientist who won two Nobel prizes in his lifetime, was credited with the following response when asked at a public lecture how one creates scientific theories: he replied that one must endeavor to come up with *many* ideas—then discard the useless ones.

This process is articulated in collaborativist learning: the advance from divergent to convergent thinking. Three stages define the process: Idea Generating, Idea Organizing and Intellectual Convergence (Harasim, 2002). Below is a brief introduction to these terms (these stages are addressed in greater detail in the section on collaborativist pedagogy).

1. **Idea Generating**. The first phase, *Idea Generating*, refers to divergent thinking within a group: brainstorming, verbalization, generating information, and thus sharing of ideas and positions on a particular topic or problem.
2. **Idea Organizing**. Phase two, *Idea Organizing*, is the beginning of conceptual change, demonstrating intellectual progress and the beginning of convergence as participants confront new or different ideas, clarify and cluster these new ideas according to their relationship and similarities to one another, selecting the strongest and weeding out weaker positions (referencing, agreement, disagreement or questioning).
3. **Intellectual Convergence**. The third phase, *Intellectual Convergence*, is typically reflected in shared understanding (including agreeing to disagree), or a mutual contribution to and construction of a knowledge product or solution.

Figure 7.2 illustrates these three stages of collaborative discourse from Idea Generating (IG) to Intellectual Convergence (IC). At the IG stage, individual students contribute their ideas and opinions to the group. Through the process of brainstorming, the students express their own ideas and begin to confront ideas generated by others in the group. This leads to the second stage of the discourse—Idea Organizing (IO). At this stage, the students reflect on the various ideas presented and begin to interact with one another. Their discussions are continually informed by readings and other resources provided by the teacher (or moderator) and they begin to learn and to use the analytical concepts of the discipline. They are adopting a common language and framework. They agree or disagree, clarify, question, critique, elaborate and reject some ideas, while identifying relationships and organizing linkages to highlight the stronger ideas. The result is convergence: several small ideas become a few large ones and individual understandings grow into group analyses. Throughout this process, many ideas are discarded.

At this point, the discourse advances to the third level—IC. By stage 3, the group actively engages in the co-construction of knowledge based on shared understanding. The group members synthesize their ideas and knowledge into explicit points of view or positions on the topic. The outcomes of this stage are consolidated, shared understandings that represent group convergence as evidenced by conclusive statements and/or co-production (such as theories, positions, strategies, tools, manifestos and scientific theories/hypotheses).

These may lead to social applications, represented as gears in Figure 7.2. Or they may lead to further debate, discussion and the refinement of the concepts as suggested by the feedback arrows. The process is not circular, but one of continual growth and advancement based on a feedback spiral. The phase of IO may move directly to IC, or it may trigger further brainstorming (IG). More in-depth examination of each of these stages, and the role of the teacher/moderator in this process is highlighted and discussed in the next section on collaborativist pedagogy.

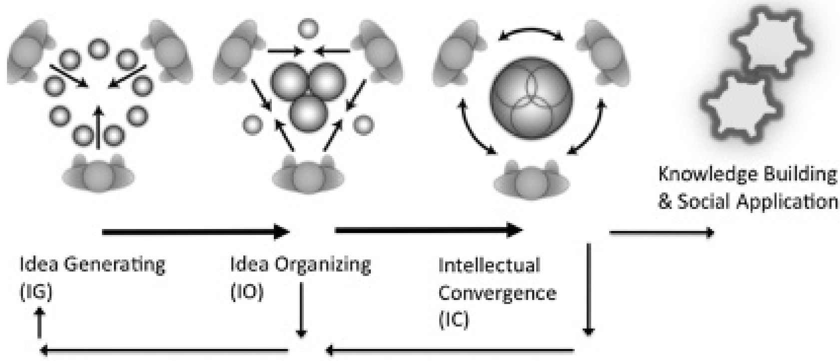


Figure 7.2 Three Intellectual Phases of Collaborativism.

Collaborativist Pedagogy

Online learning has been adopted at all levels of education, from public schools and universities, to training and continuing and corporate education. Many educators have engaged in online, blended or flipped classroom teaching. However, the pedagogy of these approaches and, even more important, the purpose and goals of the pedagogies remain unclear or, possibly, unknown.

The Role of the Teacher

As previously emphasized, in collaborativist theory and pedagogy, the teacher plays a key and essential role—a role that is neither as "guide on the side" nor "sage on the stage." Recognizing the importance of discourse in learning, the role of the educator is to engage the learners in the specific language or vocabulary and activities associated with building the discipline. As such, the teacher acts as a representative and a gateway to the knowledge community within a particular discipline.

> In accepting this responsibility, professors set out to help students acquire fluency in the language of those communities, so that they become, if not necessarily new professionals, then people who are "literarily-minded," "mathematically minded," "sociologically minded," and so on. That is, the students learn more than disciplinary jargon. Their education is reacculturation involving intense, flexible linguistic engagement with members of communities they already belong to and communities to which they do not yet belong. (Bruffee, 1999, p. 154)

IMPLEMENTING THE THREE PROCESSES OF COLLABORATIVIST PEDAGOGY

To help illustrate this intellectual process, we examine a generic online group discussion or seminar, which begins with small group discussions on a topic, then progresses.

Figure 7.3 depicts the pedagogy of a group discussion and the progress from Idea Generating to Idea Organizing to Intellectual Convergence. This process approximates the process of discussion and science within the knowledge community. The role of the teacher is as a facilitator with the students and, as a representative of the knowledge community, re-acculturating the students into the discourse of the knowledge community of that discipline.

We can view this process as exemplified by a group discussion (or seminar, debate, etc.).

1. **Idea Generating**. Learners engage in a group discussion of a specific topic, question or knowledge problem in their discipline. Each participant logs on to the discussion to present his or her initial views on the subject. The teacher or moderator introduces the processes

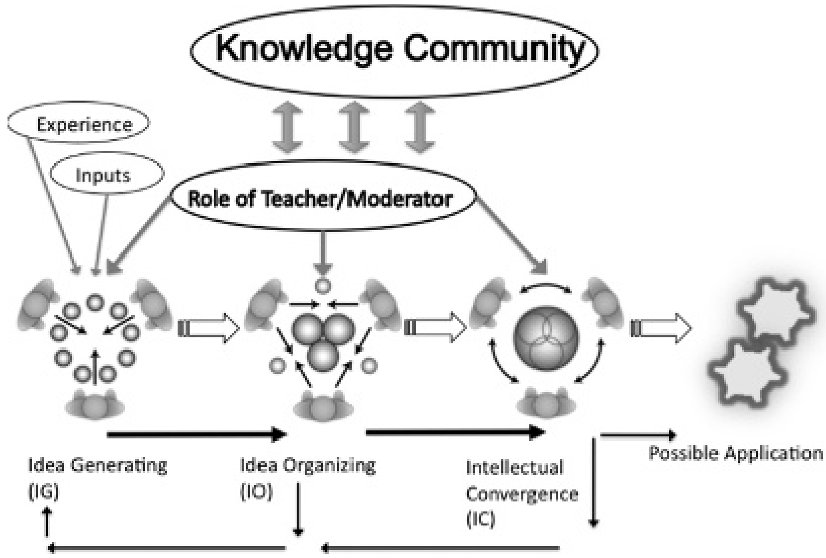


Figure 7.3 Example Collaborativist Processes in a Class.

of the discussion and the knowledge problem to be discussed. Idea Generating (also known as brainstorming) encourages participants to articulate their views and generate a range of divergent perspectives on the topic. This phase is highly democratic; everyone presents one or several ideas. Students also begin to introduce new ideas from the readings provided by the professor or moderator.

2. **Idea Organizing**. Learners interact with one another, confront the perspectives generated by their peers as well as ideas from the readings and other sources of information proposed by the professor or group members. The input has grown and has enriched each learner's awareness and appreciation of how the topic can be viewed. Learners begin to organize, analyze and filter the range of ideas by agreeing or disagreeing with some of the ideas presented, elaborating, expanding or rejecting others. Input from the teacher/moderator such as course readings and comments that facilitate the discussion reflect the influence of the knowledge community as the frame of reference. The teacher continues to introduce new analytical terms which are applied by the students to deepen the discussion and understanding of the topic. Some Idea Generating may occur but primarily the phase of Idea Organizing is characterized by applying analytical concepts and references to the literature in order to organize or cluster common ideas into fewer and more refined categories.
3. **Intellectual Convergence**. Through discussion and analysis, informed by the readings and supported by the teacher/moderator, learners reach a level of Intellectual Convergence and come to a position on the topic or to a resolution of the knowledge problem. Intellectual Convergence includes (and is most typically characterized by) agreement to disagree or, in some cases, reaching a consensus. Intellectual Convergence may be reflected in a co-produced final product such as a report, a final paper, a group presentation or an intellectual statement such as a summary or landscape of the discussion. When a product is the goal (a paper, a presentation, a project or an assignment), the intellectual processes aim toward finding consensus on the shape of the final product. In more scholarly applications, the goal may be development of a design, a policy, or an artistic or scientific statement. The process of convergence may also yield a few key but distinct positions.

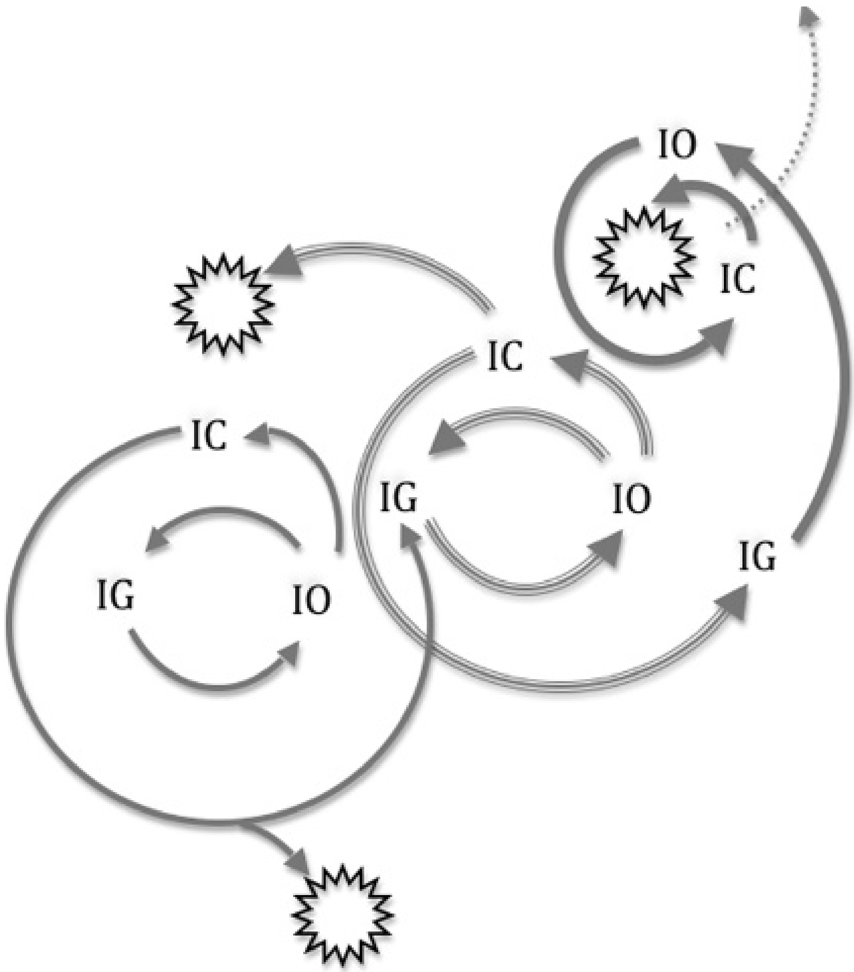


Figure 7.4 Collaborative Learning Spirals.

The Role of the Student

The role of the student in an online group discussion, seminar, or project is to engage in the three processes of collaborative discourse and to learn and apply the analytical terms of the discipline to solve a knowledge problem. This very serious process is not about students memorizing definitions or formulas: it is about learning the analytical language and applying that language to solving knowledge problems in their field. The teacher does not provide the answers. This is the responsibility of the learners as they learn how to study the problem, consider ways to understand and analyze the problem and collaborate to find ways to best resolve the knowledge problem.

Students thus are challenged to learn, problem solve and innovate using the analytic terms and their application as used by the knowledge community in that discipline. As such, they adopt the processes employed by the knowledge community. With the facilitation and support of the teacher, students increasingly become familiar with the way in which the knowledge community functions. In a course, this process likely ends with a final paper or project that applies the conclusions. In some cases, the process may repeat, iteratively to deepen the intellectual processes. Or the process may lead to real-world applications such as pre-service or in-service training.

Although many online courses today do include an online discussion forum, unfortunately the discussion is often secondary to the curriculum. When introduced as an add-on rather than a core part of the course, the discussion forum is viewed and treated as a dreary chore which students often avoid or ignore if possible, or where they post some desultory comments to gain a poorly defined participation grade. In this scenario, neither the professor nor the students view the forum as relevant, much less exciting. Analytical thinking and debate is all too often impeded rather than promoted when the discussion forum is viewed as irrelevant. Forums on peripheral topics, or based on question and answer, or forums that grade by number or volume of messages, or by individual input but not group interaction and progress, are recipes for failure. And, sadly, the blame is often placed on the use of online discussion forums, rather than on poor pedagogy.

In collaborativism, on the other hand, discussion forums and other collaboration and knowledge-building activities are central features of the course; student discussions form the course content and are *graded as primary to the course*. While readings and teacher input facilitate and shape the discussions, course content is student-generated, and assessment considers quality of student input and process. Students learn about the topic through discussing it; presenting and defending (or abandoning) their perspectives. In the process, they learn how to build knowledge and how to collaborate to solve problems.

Course resources such as readings, videos or textbooks are chosen to support discourse activities, not the other way around. Bates (2015b) notes:

> This is a key design principle, and explains why often instructors or tutors complain, in more "traditional" online courses, that students don't participate in discussions. Often this is because where online discussions are secondary to more didactic teaching, or are not deliberately designed and managed to lead to knowledge construction, students see the discussions as optional or extra work, because they have no direct impact on grades or assessment. It is also a reason why awarding grades for participation in discussion forums misses the point. It is not the extrinsic activity that counts, but the intrinsic value of the discussion, that matters.

An example of the processes involved in a student-moderated online seminar is presented in Chapter 8, Scenario 2. Here, students design, moderate and participate in online seminars thus learning, applying and thereby understanding the processes of collaborativism both as moderators and as discussants.

Collaborativist Technology

Understanding the nature of collaborativist technologies is another key to engaging in effective online learning. Online technologies play various and very distinct roles; given the astounding levels of power and control they are currently assuming, it is essential for educators to examine online learning technology's current and future role, impact and implications.

Collaborativist technology as a learning environment

The term *online learning environment* refers to web-based software that is specifically designed to host or house learning activities. An online learning environment is the online equivalent of physical architecture such as a classroom, a lecture hall, a campus, a student cafe, a seminar room, a student lab or office. Allen and Otto (1996) referred to the educational ecology of media as "lived environments" whereby users exercise their powers of perception, mobility and agency within the constraints imposed by the various technologies and learning theories and pedagogies (p. 199). They are experienced as lived spaces, to the extent that they facilitate both the perception of opportunities for acting, as well as some means for acting (Allen & Otto, 1996, p. 199).

The nature and level of "agency" is determined by the pedagogy. Whereas ODE and OC approaches (such as MOOCs) reduce human agency to consuming and reproducing "truths," collaborativist technologies facilitate a pedagogy where users can construct knowledge and negotiate meaning through conversation and collaboration, rather than just receiving or repeating information.

There is a serious need to be able to customize the online learning environment to support different activities such as discussions, debates, role plays, seminars or team projects. For example, tools embedded within the online environment could provide scaffolds for particular learning processes (IG, IO, IC), facilitating (moderating) online discussions, enabling referencing between messages, annotating messages (to enhance, grade or study a message) or allowing multiple perspectives on the message organization such as chronological presentation, by topic, by author or by some other quality. The need for tools to customize learning environments and discussion forums that go beyond generic design to support collaborative learning and knowledge building was first recognized in the late 1980s. This did not just mean generic online forums linked to quiz tools, nor sites preloaded with curricular content. The need was for online educational discourse environments customized by templates and scaffolds to support specific pedagogical principles and learning theory.

Generic network tools—such as email, computer conferencing and newsgroups—impose significant user overheads because they were not specifically designed to support educational activities. Instructors have had to expend great effort to reformulate their traditional classroom activities. Doing so with models or tools to shape the learning environment involved substantial administrative, organizational and pedagogical challenges and costs. Many experiments failed and discouraged early enthusiasts (Harasim, 1999, p. 44).

In the 1990s, efforts to develop an online learning environment to support and encourage the use of collaborative learning online led to the creation of the Virtual-U web-based learning system.

> The goal of our system, now known as the Virtual-U, was to provide a flexible framework to support advanced pedagogies based on active learning, collaboration, multiple perspectives, and knowledge building. This framework employs various instructional formats, including seminars, tutorials, group projects, and labs. (Harasim, 1999, p. 45)

The Virtual-U was one of the first online environments designed with a specific pedagogical vision and framework that guided the software design. That framework was explicitly designed to support collaborative learning and knowledge construction. The environment focused on discourse spaces that could be customized for up to 100 students in any course (20 students was seen as the most workable number, since more participants diminished the quality and ease of discussion in any class). The discourse spaces provided a number of tools to facilitate Idea Generating, Idea Organization and Intellectual Convergence. In addition, a number of embedded teacher and learner tools could configure and customize the environment in a variety of ways for individuals or groups, using various communication features (asynchronous group conferencing and synchronous chats). These are outlined below.

1. VGroups: An asynchronous computer conferencing system, VGroups was designed to enable users to discuss and debate and gain multiple perspectives on the topic. Participants could organize the online message interactions according to subject, thread, author, date or reader-set keyword. For example, learners could use the "keyword function" to identify the nature of their message (whether the message was IG, IO or IC). VGroups also provided instructors and moderators with tools to customize the discourse space by group size,

schedule and user privileges (i.e., create, delete, read-only) as well as to define discourse categories.

2. The Virtual-U environment was based on geographical metaphors to help students and instructors navigate the virtual space: each online course or online seminar had its own specific spaces for discussion, work groups, labs, cafes, personal workspaces, resources, chat space, course-design tools, administrative tools, personal calendars and course gradebooks. Messages could be text, multimedia or hyperlinked.
3. Virtual-U scaffolds and activity templates, support pedagogical techniques such as formal and informal debates, project-based learning, role plays and tools to measure different dimensions of learning processes. Users could also specify the intended discourse type of their message (IG, IO, IC).
4. VUCat, the Virtual-U Course Analysis Tool, assisted moderators. VUCat enabled monitoring of user participation (logins, number of messages read, messages written, message replies) and generated graphical displays of summary data. Such data could be accessed by the teacher/moderator or by participants (depending on how user privileges were set up by the moderator).
5. Templates for transcript analysis to categorize the messages according to the three phases of collaborativist discourse were also developed and employed by researchers, instructors and students. Students reported that such collaborativist templates were valuable for moderating online seminars and for orienting their own participation in online discussions.

Virtual-U exemplified an online environment developed to specifically facilitate collaborative learning and knowledge building. The existence of a shared space—not just an assemblage of tools—is a key feature. Moreover, the nature and design of that space affects the activity that takes place (or fails to take place) within that space. A famous concept attributed to Marshall McLuhan is relevant here: "First we shape our tools, and then our tools shape us" (Culkin, 1967). This is true for online as well as physical environments, and it is essential that educational technologies are designed to provide shared spaces that support and encourage human agency as well as equitable and collaborative learning.

Even today, two decades after the development of Virtual-U, there are few available environments especially customized for educational discourse. The rise of the open source software movement holds promise for collaborative, global construction of new and customizable collaborativist environments, but the potential has yet to be realized.

In the next section, we explore the current attributes of collaborativist environments from the perspective of the potential benefits and limitations of online forums in supporting collaboration and knowledge-building *discourse*.

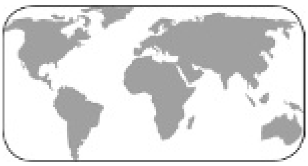
Attributes of Collaborativist or Online Collaborative Environments Today

The environments in which we live, learn, work and socialize are all characterized by attributes that enable certain kinds of activities, and limit or negate others. Face-to-face environments have particular attributes and affordances while online environments have others. Collaborativist environments, specifically discussion forums, are characterized by discourse with the following five attributes:

1. place-independent discourse;
2. time-independent (as well as synchronous) discourse;
3. many-to-many discourse (as well as one-to-many and one-to-one communication);
4. text-based (with multimedia) discourse;
5. internet-mediated discourse.

While the first four attributes are important, it is the fifth attribute, *internet mediation,* that will distinguish and potentially decide the future of education and humanity. A brief discussion follows of some of the ways in which the current attributes can affect collaborativist discourse and on what, ultimately, is at stake with regard to the two distinct epistemologies and their implications for the future.

1. PLACE-INDEPENDENT DISCOURSE



Among the most obvious and powerful attributes of the internet is place-independent discourse. The ability to communicate and collaborate beyond classroom walls has introduced profound shifts in teaching and learning. Perhaps the primary implication of place-independent discourse is access, a critical goal of school, college, workplace and corporate education.

Online education has a global reach which offers tremendous advantages for learning. Place independence enables educational access for learners in remote areas, in parts of the world which lack access to particular disciplines of study, particular expertise or appropriate levels of study. It enables educational access to learners who may have to travel for work, who can still participate in online education while on the road, or those who have family or other responsibilities, or physical disabilities, that preclude travel to a place-based campus.

Place-independent discourse also has significant implications for the quality of learning and knowledge building. It enables greatly expanded student participation, and hence the quality and nature of the ideas generated and debated are potentially enriched. Discourse in collaborativist environments benefits from access to new cultures, perspectives and input: multiple perspectives

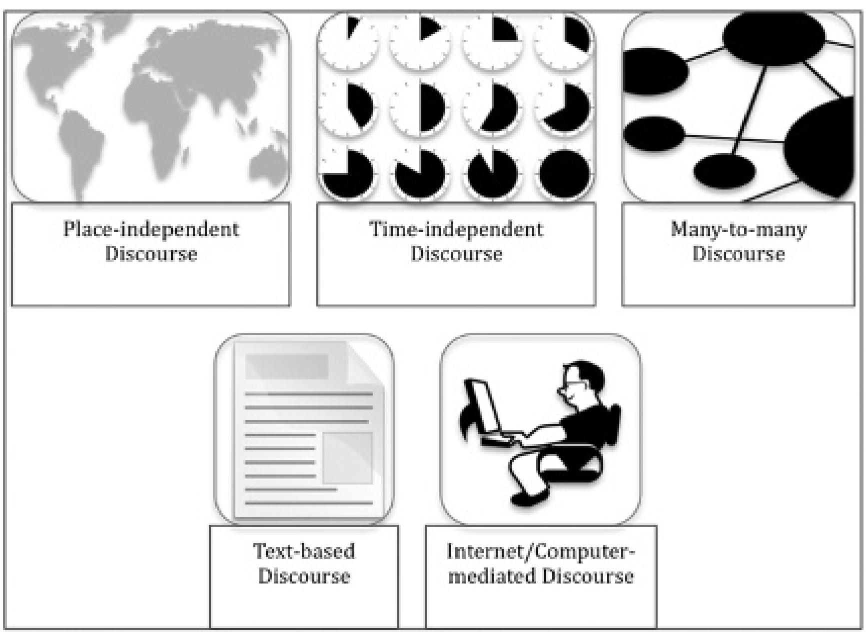
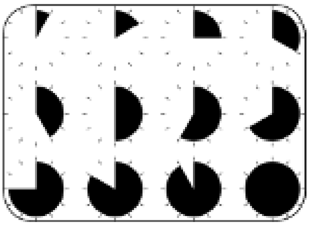


Figure 7.5 Types of Online Discourse.

are encouraged given the inclusion of participants from diverse locations and backgrounds. Place-independent discourse also enables the inclusion of guest experts or participants from outside the class to enhance the discussions.

Place-independent discourse also introduces new challenges. In the case of global or cross-cultural discussions, there is a need for participants to become sensitized to cultural differences and nuances (some cultures may be more loquacious, while others value more formal interactions).

2. TIME-INDEPENDENT (ASYNCHRONOUS) DISCOURSE

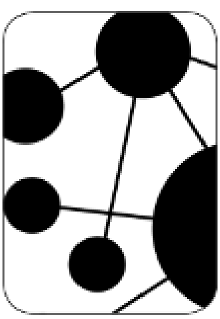


A second attribute of online learning is time independence or asynchronicity. Collaborativism is typically asynchronous, although synchronous (real-time) course delivery and group interaction are conducted through video-conferencing and audio-conferencing technologies such as Skype.

Asynchronous access means that the online class is available 24/7—24 hours a day, 7 days a week. Time-independent discourse introduces a number of benefits for learning and knowledge building. Students do, in fact, access online learning activities 24/7, to read and write messages at all hours of the day and night. Such expanded access enables online discussions to be highly active and interactive. There is no limit to airtime and students can always provide input. Feedback on ideas posted online can be relatively immediate or discussion and debate can be refined, advancing an idea over time. Students can take more time if needed to draft a thoughtful response and access resources to inform and enhance their input. Students can also take advantage of spell checkers or grammar guides, to write and edit a comment.

Asynchronous discourse offers participants time to reflect on an idea or message, and take the necessary time to formulate a response. Learners can participate at their best learning-readiness times, especially important if they have family or other obligations that are time sensitive. They can participate at a time that is most convenient to them and appropriate to the course activity. Asynchronous communication also facilitates discourse across time zones.

3. GROUP (MANY–MANY) DISCOURSE



The ability to engage in group or many-to-many discourse is the basis for collaboration and knowledge building. As has been discussed throughout this chapter, group input enables multiple perspectives to enrich consideration of an idea or topic. Online forums or conferencing systems were developed to permit group conversations, and hence allow all participants to input their own ideas and thereby create a diversity of ideas, reactions and feedback on the discussion topic. Forums have proven to be excellent environments for communicating divergent input, such as verbalization and brainstorming. They support creativity by enabling participants to draw on ideas from many perspectives and diverse sources; the ability to respond to and interact with a range of ideas allows participants to refine and improve their understanding and knowledge.

Unfortunately, current online forum systems are not well designed to facilitate convergent thinking and this requires the instructor or moderator to organize and structure the group discussions into intellectual processes that lead to convergence and conclusions. Online discourse would greatly benefit from tools and techniques that could help to organize the diverse and potentially voluminous input while encouraging intellectual progress. Such frameworks and tools are not yet available.

4. TEXT-BASED DISCOURSE

Collaborativist discourse is primarily text-based, although multimedia tools such as audio, video, animation and even avatars may be incorporated into online course activities and discourse. While some educators may question the use of text as the primary medium of communication in online learning (in preference to audio, video or animation), text is the established mode of academic, scientific and intellectual discourse.

While discourse plays a key role in learning, text or writing is considered the most important type of conversation in knowledge building. Bruffee (1999) emphasized that scientists are "'compulsive and almost manic writers.' … Conversation among scientists illustrates, further, how we construct knowledge in every field and walks of life" (p. 53).

Lev Vygotsky (1962) posited the importance of writing to the process of knowing. The articulation of thoughts into written speech involves analytical deliberation: "The change from maximally compact inner speech to maximally detailed written speech requires what may be called deliberate semantics—deliberate structuring of the web of meaning" (pp. 99–100). Discourse and writing are powerful articulations and representations of our thoughts. It is how we express and communicate our thoughts, to others and to ourselves.

McGinley and Tierney (1989) emphasize the importance of writing in the construction of meaning and how we come to know, and cite this insightful statement by J. Gage (1986):

> Writing is thinking made tangible, thinking that can be examined because it is on the page and not in the head invisibly floating around. Writing is thinking that can be stopped and tinkered with. It is a way of holding thought still enough to examine its structure, its flaws. The road to clearer understanding of one's thoughts is travelled on paper. It is through an attempt to find words for ourselves in which to express related ideas that we often discover what we think. (Cited in McGinley & Tierney, 1989, p. 24)

Writing is thinking made visible, whereby it is subject to consideration and comment. Whether on the screen or on paper, writing is a way of discovering what we think and also a means of improving our ideas and discourse. Online discourse, moreover, is archived by the forum or computer conferencing software. This creates an accurate and verbatim transcript that learners and educators can access for replying to comments, reviewing the discussion, making multiple passes through the transcript and for retrospective analysis or assessment.

Online text is a compelling attribute for peer discussion and debate. Given the transmission speeds required for sending and receiving text, online text is accessible around the globe. According to a 2014 Pew Center study, a median of 78% of mobile phone owners in emerging countries use their devices for texting. Moreover, millennials prefer texting to talking by cellphone. Texting is the #1 way teens communicate with friends (Pew Research Center, 2015).

At the same time, online learning activities are now incorporating multimedia, such as the introduction of sophisticated simulations, augmented reality and immersive environments (see Chapter 8 for examples).

5. INTERNET-MEDIATED DISCOURSE

Internet-mediated discourse, the last of the five attributes, is also the most potent given the range and scope of information, the vast repository of tools and resources, and the astounding number of people participating and accessible on the internet. Moreover, the growth of AI and other forms of network intelligence is significantly expanding the capacity and role of the internet. The rise of the internet, and the speed and scope of future plans and projections, are beyond anything human society has experienced to date, with significant ramifications for education.

Today, we have easy access at our fingertips to a global knowledge network whereby we can learn from all kinds of people and digital resources. The internet is an incredible repository of information and expertise that is easily accessed and offers immense rewards. We may intentionally seek specific data or resources, or serendipitously discover new insights and ideas or expand/refine existing ones.

Internet-mediated discourse already provides us with access to an astounding myriad of resources that can be hyperlinked into our messages, blogs or discussions to provide new perspectives, information or evidence. Text, graphics and videos are easily incorporated into our discourse to enrich or illuminate our position. And the rate of technological change and computing power is accelerating.

Powerful new digital media are emerging at a phenomenal rate to create qualitatively new dimensions of discourse, collaboration and knowledge construction. Digital media have unprecedented power and implications for humanity, and educators need to be aware of the new powers and to consider their implications when making policy and pedagogical decisions. Powerful sentient technologies are being built to not only replace human labor but also human intelligence. Within this technological revolution, two divergent avenues are emerging: the constructivist epistemological model which promotes augmented human intelligence (AHI), as primary versus the objectivist path which promotes artificial intelligence (AI) as primary.

Augmented Human Intelligence (AHI) Versus Artificial Intelligence (AI)

Augmented human intelligence (AHI) is a concept coined here to signify the extension and augmentation of human intelligence through education, communication, experience and technology. It posits the human being as central, rather than the technology. Thus, AHI requires that advanced technologies be designed and used to enhance and augment rather than replace or reduce human intelligence. In contrast, an AI-driven approach to learning places technology in the central controlling role, with students as objects rather than active participants.

The concept of AHI needs urgent consideration by educators and society as a counter to the promotion of AI in education and the current intense media support of automated education.

Tony Bates (2016) warns that AI systems in education are increasingly automating rather than empowering the learner:

> The danger then with automation is that we drive humans to learn in ways that best suit how machines operate, and thus deny humans the potential of developing the higher levels of thinking that make humans different from machines. For instance, humans are better than machines at dealing with volatile, uncertain, complex and ambiguous situations, which is where we find ourselves in today's society. (Bates, 2016)

Educational platforms such as MOOCs diminish human intelligence by requiring learners to repeat a "correct" answer, a form of obedience to technology and to the content. MOOCs provide an educational environment in which the role of the student is to repeat the correct answer in quizzes by "clicking" on one answer, over and over. Monotonous, repetitive, mindless "clicks." No discussion, just click. Clicking replaces thinking.

Moreover, AI runs on algorithms that predict or direct human behavior. Technological investments in education such as MOOCs, adaptive learning systems (ALS) and personalized learning environments (PLEs), aim to replace live teachers with computer algorithms designed and owned by corporate interests. Education thus becomes controlled by the corporations who own those algorithms. Bates (2016) points out:

> These algorithms though are not transparent to the end users. To give an example, learning analytics are being used to identify students at high risk of failure, based on correlations of previous behavior online by previous students. However, for an individual, should a software program be making the decision as to whether that person is suitable for higher education or a particular course? If so, should that person know the grounds on which they are considered unsuitable and be able to challenge the algorithm or at least the principles on which that algorithm is based? Who makes the decision about these algorithms – a computer scientist using correlated data, or an educator concerned with equitable access? The more we try to automate learning, the greater the danger of unintended consequences, and the more need for educators rather than computer scientists to control the decision-making. (ibid.)

AHI, on the other hand, emphasizes the design and use of technologies and pedagogies that support human learning and the student while extending and advancing human thinking. Technologies that augment human intelligence are designed to serve and advance human intelligence, rather than reduce or replace it. Due to the creeping reach of AI in all aspects of technology, there is a very urgent need to create open source AHI, whereby the design of source code is visible and available for analysis, and can be discussed and understood by all.

Back in 1962, Douglas Engelbart presented a defining conceptual framework for what he called "augmented human intellect":

> By "augmenting human intellect" we mean increasing the capability of a man to approach a complex problem situation, to gain comprehension to suit his particular needs, and to derive solutions to problems. … We do not speak of isolated clever tricks that help in particular situations. We refer to a way of life in an integrated domain where hunches, "feel for a situation" usefully co-exist with powerful concepts, streamlined terminology and notation, sophisticated methods, and high-powered electronic aids. (Engelbart, 1962)

As a species we have been augmenting our intelligence for millennia. As discussed in Chapters 1 and 2, human development has advanced through our invention of the technologies of speech, writing and publishing—technologies that facilitate knowledge sharing and which enhance rather than reduce or replace us.

Today, educators face a far greater challenge with evolving technologies that rival and potentially surpass humans in terms of physical labor, sentience and intelligence. The robot revolution in the workplace already signals a future in which labor no longer commands value. The blue-collar worker, as well as the white-collar professional, face the prospect of becoming an "endangered species," displaced by robots and AI. Computers, ascending to unprecedented powers, are replacing factory workers, construction workers and increasingly dentists, pharmacists, surgeons, journalists and—given the examples of MOOCs, ALS, PLEs—also teachers. Machines could take over what we today call "knowledge work."

As massive investments in computer networking and artificial intelligence transform AI from computer-based programs designed by humans to systems which program themselves, human irrelevance and mass unemployment become very real dangers. In this scenario, humans are superseded by technology. Ray Kurzweil, chief engineer at Google, is a well-known proponent of the *singularity*, the point at which, he argues, machine intelligence will match and exceed human intelligence. His 2006 book, *The Singularity is Near: When Humans Transcend Biology*, promotes the superiority of technology and advocates the union of humans with technology, a union referred to as *transhumanism*. Others write about the dangers of creating sentient beings more powerful than us, that humans will not be able to control, and that will easily be able to outsmart, outwork and outcompete humans in all ways. Books such as James Barratt's *Our Final Invention: Artificial Intelligence and the End of the Human Era* (2013), Nick Bostrom's book, *SuperIntelligence* (2014) and *They Know Everything about You* (2015) by Robert Scheer are among a myriad that consider the implications of artificial super-intelligence and a dystopic future for the human race.

The nature of AI presented today emphasizes logic over creativity or ethics. The efficiency of technology marks its superiority over humanity, and over such issues as ethics, principles or values. Technology is deemed to be purer than the values of society or social well-being or even those of the computer scientists who first programmed them.

Adherents of AI and the *singularity* view future technology as a programming challenge, and believe that they are creating a "solution," a "species" superior to humanity. Computer programs are now being developed by computers, often beyond the comprehension of computer scientists. Such programs are not yet considered a threat by many scientists. Such programs are not yet considered a threat by many scientist who view AI as embodying pure intentions.

But there are very strong voices warning against AI. Famous physicist, Stephen Hawking, one of Britain's pre-eminent scientists, has stated that efforts to create thinking machines pose a threat to our very existence. "The development of full artificial intelligence could spell the end of the human race," the world-renowned physicist told the BBC's Rory Cellan-Jones during a 2014 interview. "It would take off on its own and re-design itself at an ever increasing rate. Humans, who are limited by slow biological evolution, couldn't compete, and would be superseded" (Cellan-Jones, 2014). Hawking has been voicing this apocalyptic vision for a while. In a response to *Transcendence*, the sci-fi movie about the singularity starring Johnny Depp, Hawking criticized researchers for not doing more to protect humans from the risks of AI. "If a superior alien civilization sent us a message saying, 'We'll arrive in a few decades,' would we just reply, 'OK, call us when you get here—we'll leave the lights on'? Probably not—but this is more or less what is happening with AI" (Hawking, Russel, Tegmark, & Wilczek, 2014).

Elon Musk, thought leader and entrepreneur who launched cutting-edge technologies such as the Tesla car and SpaceX, space rockets that travel to Mars, has expressed significant concerns about AI. In 2014 he tweeted that AI was "potentially more dangerous than nukes," and later that year he told Massachusetts Institute of Technology (MIT) students that AI was "our biggest existential threat" (Gibbs, 2014). At a conference at MIT in October 2014, Musk likened improving AI to "summoning the demon" (Luckerson, 2014).

In December 2015, Musk and other AI critics announced the launch of OpenAI (Kelly, 2015). OpenAI's goal is to develop AI safely and share its research widely. OpenAI is specifically meant to be used in ways that will benefit humanity.

Huge mega-corporations, such as Google, Apple, Microsoft, Facebook and Amazon, have been investing heavily in AI for their own private profit and knowledge. To counter this, OpenAI's backers—a group that includes Musk, Peter Thiel, Reid Hoffman and Y Combinator's Sam Altman and Jessica Livingston—are committing US$1 billion to the project. "I believe it's better to empower human kind with distributed artificial intelligence than a central artificial intelligence controlled by a single company," said Altman in an interview. Altman has concerns about the technology but instead of being worried and doing nothing, he feels it's better to be active in the field. "I sleep better knowing I can have some influence now," he said (Kelly, 2015). Musk warned in an interview with CNN that, "Humanity's position on this planet depends on its intelligence, so if our intelligence is exceeded, it's unlikely we will remain in charge of the planet" (ibid.).

Likewise, education's challenge, then, is to design and implement educational and socio-economic strategies to contribute to an enlightened society and Knowledge Age on a global scale, to augment human learning and progress and to avoid the negative implications of a reliance on AI.

This may well be possible if educators immediately take up the challenge and begin to engage in conversations with one another, with students and/or the public, locally and globally, about the nature of these challenges and our potential to recreate and transform teaching and learning in order to augment human thinking, creativity, equity, ethics and civil understanding. We need theories and pedagogies such as collaborativism to offset the drive towards the automation of education, and to instead support effective and powerful learning and knowledge-building capabilities in which technology enhances and amplifies but does not replace human creativity, autonomy and control.

We need to pay serious attention to epistemology; that is, to truly understand what a particular theory, pedagogy or educational technology is promoting. Educational pedagogy and technologies are NOT neutral. They are intentional and support specific views of the world.

The epistemological basis of key theories of learning become clear as we look back over the past five chapters. The objectivist epistemologies behind learning theories such as behaviorism, cognitivism and connectivism all seek efficiency over effectiveness, and perceive technology as superior to human ability and agency. They focus solely on the solution, and in large part disregard any analysis of the problem. The solution is always viewed as a new technology and, most often, a new way to profit.

This objectivist epistemology is reflected in Silicon Valley's start-up mentality. Disruption is the mantra and a rationale for imposing a solution, without necessarily studying or understanding the problem. The start-up seeks to succeed by disrupting or destroying what existed in its place. Professionals associated with applied sciences, in particular engineers and computer scientists, are often keen for solutions regardless of the need or, especially, regardless of the problem. However, "disruption" should be viewed with extreme caution—not with blind optimism as a get-rich quick scheme. Disruption means the breakdown or destruction of existing institutions and activities, often carefully built up over decades or even centuries. Exuberant disruption without a well-considered or tested solution is serious and could be extremely expensive if not fatal.

In announcing their US$45 billion investment, Facebook founder and CEO Mark Zuckerberg and his wife, pediatrician Priscilla Chan, stated that they would use their massive fortune to reshape public education with technology. "We think that personalized learning makes sense," Zuckerberg told *Education Week* in a recent telephone interview. "We want to see as many good versions of this idea as possible get tested in the world." They also stated that they would support the development of software "that understands how you learn best and where you need to focus" (Saul, 2015).

This is a scary scenario. Who will have ultimate say on the pedagogical approach to ensure that educational efforts result in improving rather than dumbing down the students? What is the definition of education that "makes sense" or what constitutes "good versions" of such education? Education that makes sense has arguably been the general goal for the past few hundred years, if not millennia. This is not a new goal; yet the objectives of Zuckerberg's project are vague and worrying given the vast investment but ambiguous ambitions. What would distinguish the Facebook approach to learning? What definitions of learning are being employed? Based on what theory and epistemology? What research? Will teacher unions, associations, research communities, academics, the public or even governments be consulted about this particular "philanthropy"? In fact, the Chan Zuckerberg Initiative (CZI) is not a donation or philanthropy, but a Limited Liability Corporation which maintains control of the money, and can invest it in a variety of ways including funding for-profit companies, paying for lobbyists and shaping social policy—and can do so with decreased transparency regarding how the money is used than is the case with traditional philanthropy.

It is not clear whether the CZI investment corporation will contribute to social betterment, or be money wielded for potential social control. The notion of software that understands "where you need to focus" sounds ominous. Education ceases to be a social, cultural and economic vehicle for human progress when it becomes a tool for corporate profit. We must insist on evidence that any applied technologies have social, educational and ethical value. How will applied software algorithms "understand how you learn best and where you need to focus"? Who and what ideology will be in control of determining the social and educational values based on an "idea" that Zuckerberg and his wife say they "think … makes sense"? The "donation" of US$45 billion could well be a social tsunami that ultimately undermines public education.

Shoshona Zuboff has studied how corporate interest in education is about changing human behavior, teaching/training participants to do the will of the company or the market.

> Among the many interviews I've conducted over the past three years, the Chief Data Scientist of a much-admired Silicon Valley company that develops applications to improve students' learning told me, "The goal of everything we do is to change people's actual behavior at scale.

> When people use our app, we can capture their behaviors, identify good and bad behaviors, and develop ways to reward the good and punish the bad. We can test how actionable our cues are for them and how profitable for us." (Zuboff, 2016)

How we view the world today, and how we act in regard to that view, depends on the epistemology and theory that we hold. The admission by the scientist in the above quote acknowledges that this learning company actively seeks to shape learner behavior in ways that are profitable to the company. That is why we need to be very aware of the nature of learning theories, their underlying epistemological perspective, and what the companies or agents of various learning platforms and pedagogies are promoting. Figure 7.6 charts how theories of learning reflect particular epistemologies.

Collaborativism and Augmented Human Intelligence (AHI)

Clearly, there is an urgent need to advance our understanding of the commonalities and differences among learning theories. As outlined in Figure 7.6, the five learning theories discussed in this book can be organized according to their epistemologies: three propound an objectivist

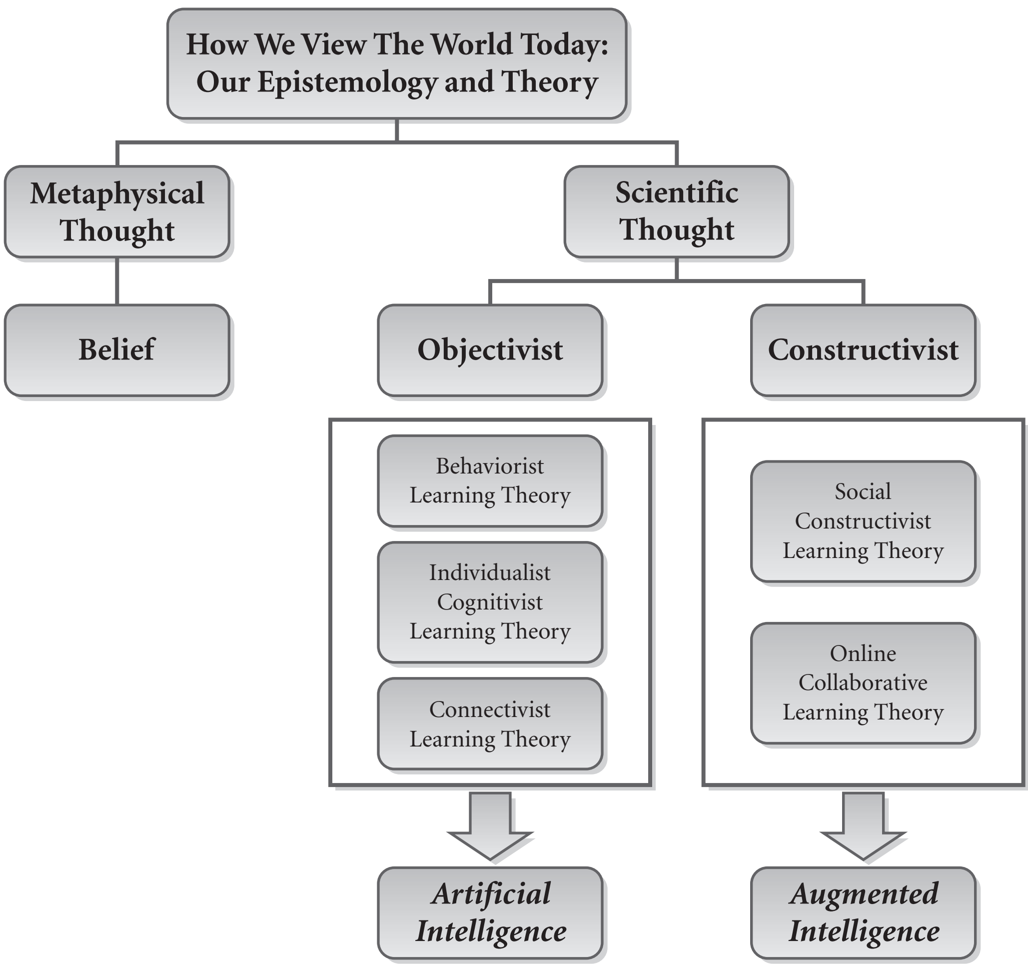


Figure 7.6 Learning Theories and Epistemologies.

epistemology and two promote a constructivist epistemology. Learning theories based on an objectivist epistemology champion individualized learning, the superiority of technology and, today, the increased adoption of AI. Learning theories based on constructivist epistemologies promote collaborative learner-centered activities, pedagogies and technologies that seek to augment human intelligence and thinking.

The major misunderstanding today is that educational access and quality is primarily an issue of technology rather than pedagogy. This misunderstanding is rooted in behaviorist, cognitivist and connectivist perspectives on learning, which promote technology over pedagogy as the solution to educational access and progress. Success is defined as quantitative; more efficient transmission of content through better technology to massive numbers of students. The key to behaviorism, cognitivism and connectivism is quantity over quality through mass replication rather than through deeper or more effective learning and understanding.

Commercial MOOC providers gain financial profit by replacing professors and instructors with AI software that disseminates video lectures in 6–10 minute chunks followed by an auto-graded quiz (aka the formula of Content + Quizzes, first formulated with the 1926 Pressey machines). MOOC providers are unable and/or unwilling to facilitate social interaction, group discourse or collaboration using AI software. The profitability of MOOCs hinges on the fact that there are no (or very few) teachers. Without teachers and/or moderators, there can be no effective opportunities for online moderated group discourse. An effective moderator must understand how to facilitate and advance online group discussion, and must also be an expert in the field—in order to promote deep learning and analysis. It is these qualities, content expertise and process facilitation, that define a *teacher*.

Daphne Koller, co-founder of the MOOC provider, Coursera, demonstrates an eerily shallow view of teaching and learning:

> there *is* no professor who is checking your work. Because the kind of scales that we're dealing with, you are not going to have someone grading the assignments of 100,000 students. So if you want to give somebody *any* feedback, you had to do it using some other mechanism. And so the first one that we put in place is autograding, where the computer checks your assignments and provides you with feedback on whether you are right or wrong. (Koller, 2014)

Koller's position reflects the objectivist epistemology where learning is correct or incorrect, right or wrong. According to Koller's framework (and the Coursera platform), learning does not have room for thinking or debate, which involves more than 0s and 1s. Autograding, Koller explains, is used for quizzes and for short answer questions: "Things that have a clear formatted output can be auto-graded—like the output of computer programs or computer models or Excel spreadsheets; math can be autograded" (ibid.). MOOCs and other forms of courseware provide a form of "McNuggetization" of information, in which students are not offered opportunities for thinking or understanding, but are given processed information to consume and regurgitate.

Critical thinking activities such as essays, analyses, arguments, reviews, debates or long answers are discouraged in MOOCs because they cannot be machine taught or machine graded. E-watching or e-reading, forms of passive learning, replace active engagement in discussion or interaction with others on the course topics. Even participation in the online quizzes drops dramatically after the 5th week, as evidenced by a study of Coursera at the University of Pennsylvania (Perna et al., 2013).

Much of the initial media hoopla around the first MOOCs focused on the issue of access to education, but access is not a synonym for learning, nor does it guarantee that learning will occur.

In recent times, Coursera has tried to improvise a form of collaborative learning by using peer grading. But this simplistic approach is hugely problematic for higher education. Without teacher facilitation or input, peer grading is weak and flawed because it relies on peers with unequal levels of knowledge, analytical abilities and assessment skills. Moreover, peer grading without external supervision by someone with knowledge of the discipline and of educational processes is unreliable and based on subjective criteria rather than professional and scientific know-how.

A Call to Action for Educators

The distinguishing characteristic of collaborativism as a theory and pedagogy is the emphasis on student discussion and collaboration facilitated by the teacher or moderator. The teacher is not a solitary figure, but represents the knowledge community to the students in that course. The knowledge community is that mix of scientists and practitioners committed to advancing the discipline, and it is their science, research, experience and debate that embodies the "state-of-the-art" in that field. Education should not be viewed as static. The "correct answer" is not a "truth" but the best answer at a given time. It is a moving target, evolving and changing as our information, experience and debates advance. A "correct" answer must be questioned and tested and distrusted, rather than memorized. Collaborativism emphasizes processes of learning such as discussion/debate, problem-solving, innovation and knowledge building.

Technology is important, but it is secondary. It should follow from and conform to the pedagogy, not the other way around. Technology should facilitate student discussion, peer collaboration and student—teacher interaction, not replace it. Analytical discourse and discussion, informed debate and access to experience and expertise are the basis of human knowledge. This has been and should continue to be facilitated and advanced by teachers, professors and educators of all kinds. But we educators have, in some key respects, dropped the ball. Education has become perceived by the public and by government as lectures and content transmission. This perception has been magnified by the media and used to the advantage of technology corporations that seek to privatize public education, and replace teachers with technology, arguing that transmission of information is better and cheaper through technology. Teachers must quickly move away from the transmission model and adopt a learning theory and pedagogy that promotes thinking and understanding, not memorization of facts.

The widespread and intensive use of digital media is impacting our literacy, our education and our relationship with the world. As teachers and educators, we need to be conscious of the context of public education, and to be especially alert to the theory of learning we advocate and employ, the pedagogy we implement and the design and application of the educational technology we incorporate into our professional world and in our own learning activities.

As Nicholas Carr (2010) cautions, reading in short bursts of attention, as we do on social media platforms, does not help us become deep and critical readers. We need sustained focus to read deeply and unless we stop media from rewiring our brains and thought processes we could irrevocably damage our human learning abilities. The same warning applies to education: offering students chunks of information followed by a quiz creates a fast-food correlate for education, one that promotes consumerism not analytical thinking. Consequently, deep and immersed reading, thinking, discourse and critical thinking are becoming at risk in our generation, and it is critical that educators step up to meet the challenge and make the case that they are both relevant and essential in today's world.

The path to learning about the world through questioning, analyzing, engaging in deep thought and innovation has always been based on group discourse and debate. Deep reflection and critical thought lead us to new ideas, analysis, discussion—even argument—that ultimately advance the processes of the Knowledge Community. Science, art, culture and technology are human artifacts

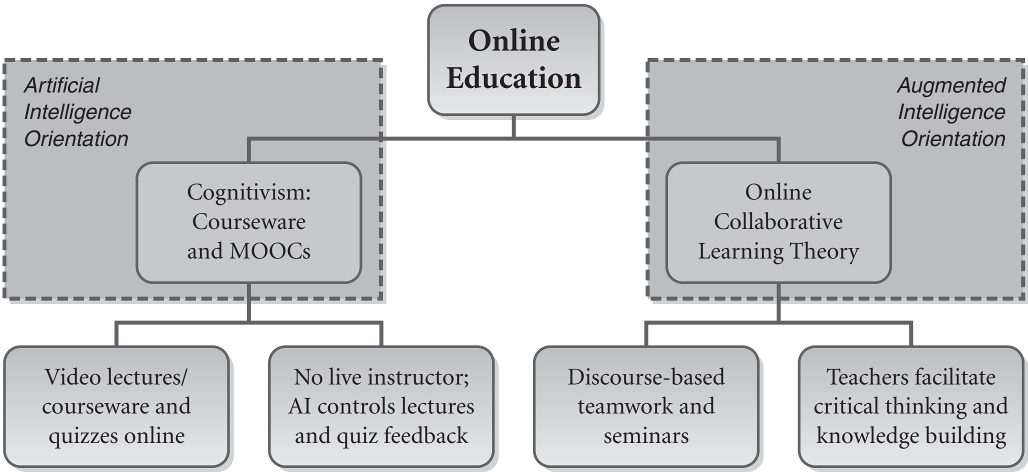


Figure 7.7 Learning Theories and Pedagogies.

that are based on, and reflect, "talk": conversations among humans communicating about what is important.

Instructors at all levels are key to the process of teaching, learning and inducting learners into better understanding the world through problem-solving and working together to generate increasingly better ways to address problems. Deep learning and analytical thinking cannot be automated. Learning is optimized when educators and learners benefit from a variety of tools and environments to support and facilitate knowledge building and sharing.

New tools and environments are necessary to continually improve and advance learning activities, but it is only human teachers that can address the complexities of real world problems and human experience. Given the challenges posed by the rise of AI, teachers must see the writing on the wall and change their pedagogies in order to assert their relevance for the 21st-century Knowledge Age.

Summary

As Chapter 7 has underscored, for tens or perhaps hundreds of thousands of years, technology has been developed to benefit and advance humanity. With the invention of computer networking in 1969, email in 1970, computer conferencing in 1972, the public internet in 1989 and the World Wide Web in 1993, online technologies were viewed as largely beneficent forces for humanity. These are the forces that created the notion and practice of online communities of interest, communities of practice, of art, of learning and many other social, cultural and professional knowledge-sharing and knowledge-building communities. These are the forces that brought us new ways of working, computer-supported collaborative learning, computer-supported cooperative work and many other network-related initiatives.

Digitization of socila media, i.e., the use of AI in all appliances, has transformed publicly utilized technologies from their social, cultural and economic origins into a means of mass data collection, surveillance and social control over humans. Robots are replacing workers and AI threatens to make most humans irrelevant and unnecessary. The threat is real, dire and advancing rapidly but it does not have to be inevitable.

Educators, in particular, can make a huge difference. Stephen Hawking issued a powerful observation and call to action for humanity, one especially poignant and relevant to educators.

Stephen Hawking states:

> We are not going to stop making progress, or reverse it, so we have to recognize the dangers and control them. I'm an optimist, and I believe we can. … It's important to ensure that these changes are heading in the right directions. In a democratic society, this means that everyone needs to have a basic understanding of science to make informed decisions about the future. (Griffin, 2016)

Educators are one of the key channels for ensuring that "these changes are heading in the right directions" and that everyone has "a basic understanding of science to make informed decisions about the future" (ibid.).

Chapter 7 introduced collaborativism, formerly known as online collaborative learning (OCL), as a theory and a framework for pedagogical and technological design. The chapter discussed the context of the 21st-century Knowledge Age and why a new theory of online learning is essential. The history of online learning was introduced to provide a timeline and a view of the development of collaborativism over the past four decades.

An exploration of the definitions of collaborativist theory and pedagogy was provided to enable readers to distinguish among the various models that may be implicit in the concept of "online education," and to understand the need to clarify the theoretical foundations embedded in the use of the related terms.

Effective online learning tools and environments were also discussed, with some illustrations from the field to demonstrate new directions in collaborativist technologies.

The chapter concluded by considering the impact and the implications of powerful new tools for education today. AI is a major force in research labs and digital media, and there is an urgent need for educators to become aware of both the potentials and the dangers, and become active in shaping AI research and development to ensure that it augments rather than subverts human dominance and intelligence. The concept of augmented human intelligence together with the theory of collaborativist learning provide a framework to support this design direction.

8
Collaborativist (aka Online Collaborative Learning or OCL) Pedagogies in Practice

> We are the inheritors, neither of an inquiry about ourselves and the world, nor of an accumulating body of information, but of a conversation, begun in the primeval forests and extended and made more articulate in the course of centuries. It is a conversation which goes on both in public and within each of ourselves. … And it is this conversation which, in the end, gives place and character to every human activity and utterance.
>
> **—Michael Oakeshott, 1962**

Chapter 8 illuminates collaborativist or online collaborative learning (OCL) pedagogies in practice and:

- Introduces four fictional students who are participating in online courses
- Presents four collaborative scenarios to provide a sample of how online courses can be designed and how the students engage:
  a. Scenario One: Online case studies (virtual simulations)
  b. Scenario Two: Student-led online seminars
  c. Scenario Three: Online global professional development program
  d. Scenario Four: Online educational games and immersive learning environments.

Introduction

Chapter 8 offers readers a means of understanding online learning, some of its different forms and how differing approaches and processes can be used to support effective learning and educational change. Four scenarios are drawn from online and blended learning models; applications that are appropriate for both formal (K–12 and university) and non-formal (professional development, training) educational contexts around the world.

The use of scenarios allows us to visualize what happens in "virtual classrooms" and online learning contexts. These scenarios offer snapshots of how an online course activity may be designed by an instructor and experienced by the learner in terms of social and intellectual interaction online. Specific examples from semi-fictionalized online learning applications help readers to envision typical "real" curricula and student interactions. Four collaborativist or OCL pedagogic scenarios from real online schools and courses are presented, although some of the details have been changed for reasons of privacy:

1. online simulations and case studies of virtual organizations;
2. student-led online seminars;
3. co-production of real-world products and programs;
4. online educational games and immersive learning environments.

To get started, we introduce four fictional students who are studying in an undergraduate degree program, online. The fictionalized students' accounts are composites of real student experiences.

Living the Online Student Life

Jennifer

Jennifer is a busy professional who nonetheless wants to complete the undergraduate degree that she started some years ago but left when she entered the job market, then married and had a family. Given her responsibilities, a place-based university with courses rigidly scheduled at specific times and locations is not realistic. She says: "For the last 10 years, I have been attempting to find the time to go back to school. I attempted the traditional classroom settings, but due to work schedules and demands I never was able to stick to it."

Barry

Barry works in sales and travels extensively, but is serious about seeking a university degree for job promotion and personal satisfaction. He regrets never attending post-secondary education. His challenge is how to pursue a university degree when his job takes him around the world weekly to destinations such as Bangkok, London and Paris, to name a few, as well as numerous cities in the US throughout the year.

Curt

Curt is in his twelfth year serving in the US Army and, given the demands associated with the role of a soldier, has found it difficult to work toward a degree: "I have attempted many times to complete an undergraduate degree to no avail. I have had to withdraw from a number of college courses due to last minute training requirements and deployments."

LeAnne

LeAnne was born, schooled and now works in the high-tech sector in Hong Kong. She is fluent in English and her goal is to move to the US in a few years to work in the same industry and advance her career. An American degree is important to her and she believes it is essential to realizing her professional goals.

Collaborativist Pedagogical Scenarios: Four Students and Online Study

These four students seek a university program to meet their needs. They find that they have many options to choose from: every year tens of millions of students in the US alone take online courses. Some of the online universities are based on distance education (ODE) or courseware (OC) approaches, so instruction is not provided by a professor. Our four students are seeking courses that have a professor or an instructor and involve peer interaction and collaborative learning. "Having peers to talk to, to share the work, the fun and the challenges makes the learning more enjoyable and more effective for me," writes Jennifer. LeAnne agrees, and adds that learning teamwork skills is important for her professionally as well.

The four find many accredited universities that offer online degrees using the collaborativist model. There are differences, however, in how each university structures its programs. Some online universities offer undergraduate and graduate degree programs based on 6 weeks per course, with approximately 12 participants in each course. Students are limited to one course at a time. Upon completion of that 6-week course, students move to the next course in their program. Other online university programs offer courses that are 12 or 15 weeks in duration, like traditional university semesters. Still other online degree programs offer a cohort system, whereby courses may start at any time, once a certain number of students have registered. Regardless of how the online courses are scheduled, all these approaches are based on a collaborative model and limit the number of students to between 10 and 25 per course.

For those of us who are unfamiliar with online study, we are curious to know more about the experiences of these four students and how an online classroom functions. Our fictional four students select to study in the same program at the same university: their online classroom is available 24 hours a day and 7 days a week. They have access to their course any time of the day or night, from anywhere in the world.

The workload is demanding but well-structured and the students feel that they are learning valuable knowledge and work habits. Barry comments that:

> The knowledge I am gaining through the program's curriculum has changed my personal and work habits. The structure almost "forces" you to get regimented to stay on track with your assignments. As a result, I have become more organized at work, which gives me more "free" time to tackle company projects. In my personal life, it's so organized, I sometimes find myself with too much free time (I am not complaining).

All of the courses use a curriculum based on individual and group assignments, and group discussion with topics that change (typically each week), leading the students into deeper and more analytical consideration of the subject matter.

Once Jennifer, for example, registers for a course, she receives the textbook and all additional course materials, or resources, either by courier or posted online. Using the internet, Jennifer logs on to the university's password-protected learning environment where each course is accessible. She will gain entry only to the course for which she is registered. While online she "meets" with the instructor and her classmates, exchanging greetings and learning about her fellow students through "self-introductions." The discussions are primarily text-based and asynchronous. The virtual classroom comprises a variety of group conferences or forums (think of "virtual rooms"); the forums or "rooms" change each week according to the topic, task and group size. Some forums are based on a full group discussion of a topic; others involve small-group discussions or projects. One forum may be "write only" where students submit their assignments to the professor, but cannot read one another's submissions. In other cases, students can access and even comment upon the work of their peers. Initially, to help facilitate the dynamics among the students who participate independently in their own time and in their own off-campus setting, the instructor begins with a full group discussion forum based on assigned readings each week. Rather than a question-and-answer format, students are encouraged to reflect on the issues raised by the instructor, consider the readings and send a thoughtful response online. Students are encouraged to submit multiple comments and ideas, and then to reflect on and respond to one another's comments—agreeing, disagreeing, expanding and advancing the ideas presented. The tone should be considered but not unnecessarily formal. As in any discussion or debate, informed opinions based on the readings or other resources are expected. This sets the tone for the course. Eventually, students will progress to other collaborative learning activities such as the virtual simulations described in Scenario One (below) or lead their own seminars, as described in Scenario Two. Social interaction is encouraged and an online social café is available for students to chat and socialize.

The tone of the seminars is not meant to be rigid but thoughtful and to emphasize evidence over emotion in the group discussions. Still, students are friendly toward one another, use first names and often start their message with a joke or social comment (for example: "Boy, is it ever snowing out here!! I am cozy in my kitchen logging on from home! It has made me reflect on the reading about access ..."). Each week the topic changes as students progress in their learning, advancing from the familiar to the less familiar, and relating the concrete with the conceptual, and the specific with the analytical. Students are introduced to analytical terms relevant to the course topic/field and, through their discussions and course readings and resources, they gain fluency in the language of analysis and its application in the field.

Typically, students work in learning groups or project teams to complete an assignment. Assignments may be brief or complex, individual or group-oriented. The role of the instructor is to serve as the representative of the knowledge community in that discipline: to supply the learning materials, provide the orientation through presentations on a topic (either by text or audio/video podcast), introduce key analytical terms and concepts through course readings and other resources and organize the learning processes to encourage student learning and problem-solving. Group seminars encourage students to learn to apply new terms and concepts and to engage in knowledge-building processes. The instructor plays an important role in organizing the seminars, especially in the situation where students will serve as seminar leaders or moderators. Student-led seminars require important instructor input to assist students to learn how to be a moderator, as well as how to be a discussant in the seminars. These are new roles for traditional classroom or distance education instructors and students. Moderators will need to learn about online group dynamics, the subject matter and how to facilitate collaborative learning and intellectual progress. Moderating requires more than group dynamics; it requires that moderators engage the discussants in knowledge building on the topic. In educational seminars or group discussion, the moderators become the most knowledgeable about their particular topic, because they have done significant background study in order to prepare to lead the seminar and facilitate the discussion to advance the discourse from Idea Generating to Idea Organizing to Intellectual Convergence (the collaborativist framework discussed in Chapter 7). Moderators must understand how to guide and facilitate the group discussion to ensure that there is learning, that the discussants are advancing in their understanding of the topic and that they are engaging with the knowledge problems and contributing to meaningful interaction and improving ideas on the topic. Students are learning to solve problems and construct knowledge together, knowledge that reflects state-of-the-art thinking in their discipline (the knowledge community) and that has real-world relevance. They learn the analytical terms of the field and they learn how to apply these terms and concepts to real-world problems, to generate knowledge artifacts such as new designs, prototypes, processes or solutions. Learning is part of the process of problem-solving: students must identify what they need to learn to resolve the problem.

Scenario One: Online Case Studies (Simulations)

A case study is an analysis of a system by observing specific situations or processes in order to solve problems. Case studies are used in many higher education academic and training disciplines to simulate real-life scenarios. Students are assigned cases and typically work in small groups to gain an understanding of their case, diagnose and develop solutions to resolve the problems posed. Traditionally, educational case studies have been presented in hardcopy, either in textbook or casebook format.

The use of online case studies is an innovative collaborativist pedagogy that promotes interaction and use of real problem-solving tools and processes. Online case studies offer important new features and learning opportunities beyond traditional textbook approaches, such as expanded opportunities for interactivity, variety and hence increased realism. In traditional textbook case studies, students are provided with a large amount of background information. The problem with traditional textbook cases is that students have no way of finding additional information, and no one to ask questions of in trying to clarify the problem. "There are none of the simulated interviews, none of the memos, none of the electronic correspondence that we have in the virtual organizations. So if you have questions on a case, the students have to make assumptions" (Wasley, 2008). Another benefit of online case studies is that students can use real software tools to problem solve and become more proficient in applying these tools and behaving as they would in a real-world context.

Given the access to vast arrays of data, online case studies can be designed to be imperfect and thereby encourage significant problem-solving efforts by students. Whereas textbook case studies are by necessity neatly packaged so that students can use the data that is available to problem solve, online case studies may be far more complex and provide what is referred to as ill-defined problems, which require students to solve problems by trying out various tools to access and manipulate different data. An ill-defined problem is often considered to be a real-world scenario in that there is no simplistic correct answer. Textbook case studies, in contrast, typically employ "well-defined problems" to facilitate an easier solution, given the constraints on information that can be provided to students.

In the past, if instructors wanted students to engage in typical real-world cases, a major obstacle was the amount of student time required to access and organize the data. A further and very difficult problem was access to the necessary information, which required both time and permission to work with confidential and/or proprietary data.

An example of the use of a state-of-the art educational simulation is the virtual organizations software developed by the University of Phoenix for their onsite and online students. Hundreds of case studies of virtual schools and businesses have been integrated into the virtual American town of Kelsey. Unlike a static textbook case study,

> Phoenix students, instead, can tap into a virtual world where each fictional school or corporation comes with detailed, simulated scenarios that "real-world" employees are likely to encounter in the workplace. These virtual-world scenarios are not fully interactive like *Second Life*—they do not provide second-by-second feedback—but they do bring real-world problems to life. (Wasley, 2008)

The use of the online case studies also provides students in a course with a range of issues or knowledge problems, while the ability to access common data enables students to collaborate on assignments. All of the virtual organizations are located in fictional Kelsey, which has a population of 53,000 and features eight corporations, four schools, a hospital and municipal offices. Approximately 500 University of Phoenix courses (online and onsite) feature the virtual organizations in course assignments. Students may do cost–benefit analyses of outsourcing in the hospital or school cafeteria, or rewrite the menus based on new health or policy considerations. Students in information technology (IT) courses may analyze the user logs or IT service requests

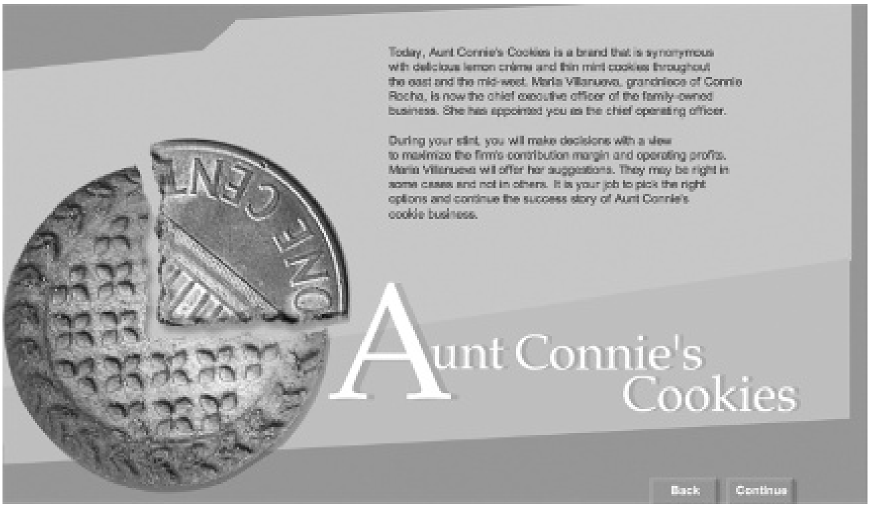


Figure 8.1 Aunt Connie's Cookies.

to diagnose software problems. Students in education may be asked to examine the student records to identify learning problems in particular areas and propose activities to address the problems.

"Students say the software gives them a view of how the parts of an organization work together. Most schoolteachers see test scores and other data only for the grade levels they teach," says Katy Wilkins, an assistant principal at a middle school that used Phoenix's virtual school program in two Master's level education courses. "The Kelsey schools allow you to access the full picture," she says (quoted in Wasley, 2008).

In a course on instructional design, Wilkins noticed that the parent–teacher communication logs at Kelsey's elementary school mentioned that certain students had comprehension abilities above their grade levels, but that the school district had no program for gifted students. For her final project in the course, she proposed a professional development program to help Kelsey teachers steer gifted students toward more challenging activities.

Wilkins presented a similar proposal to her Arizona middle school, transferring the learning of the Kelsey simulation to her own school district. "With Kelsey schools right there in front of you, it makes you scratch your head and say, I wonder if we actually have something like that in our district," she says (quoted in Wasley, 2008).

Scenario Two: Student-led Online Seminars

Scenario two depicts student-led online seminars. This pedagogy is appropriate for learners at all levels: secondary school, undergraduate or graduate school, professional development and training or continuing education. The pedagogy could also be used to inform moderating of online communities of practice (discussed in Chapter 9).

THE ONLINE SEMINARS

Our virtual four students are taking an online course with 12 other students. The course curriculum features four 1-week online seminars, each on a different topic and each moderated by a team of four students. Like all students in this course, our four will engage in two distinct roles, each with specific timelines, activities and assessment:

- moderators work in teams of four to lead a 1-week online seminar;
- discussants participate actively in three 1-week seminars.

MODERATING

Moderating represents 30% of the final grade. Jennifer, Barry, Curt and LeAnne form a team to moderate a 1-week online seminar together. Each seminar involves three distinct activities:

- seminar presentation: 10%;
- seminar facilitation: 10%;
- summary and transcript analysis of the discourse: 10%.

SEMINAR PRESENTATION

Our team has identified their seminar topic and is now preparing the Presentation to launch their seminar. The Presentation is a very important, in fact critical, component since the quality of the Presentation can determine the quality of the seminar discussion input and the quality of the learning experiences of the seminar discussants. The Presentation provides the background and key information about the topic and includes categories such as those shown in Figure 8.2.

Once the moderating team has welcomed discussants to the seminar and introduced the topic, they present three Discussion Questions (DQs). Our team realizes that effective Discussion Questions are the key to successful online seminars. Well-designed DQs encourage multiple perspectives on the topic, and generate thoughtful discussions that advance intellectual organization and convergence. Excellent DQs are fuel for thought; DQs should be relevant and real, and not answerable simply by "yes" or "no." A DQ should not encourage repetitious responses (or a series of "me too!" messages). A seminar, moreover, is not a question-and-answer activity: seminars involve questions that advance understanding. Online seminars benefit from considered and thought-provoking DQs, which give focus to the discussion, motivate learning new concepts and promote deeper reflection and understanding of a topic. Discussants build on one another's input; they may agree or disagree, but through this process they should arrive at a conclusion or a position on the topic.

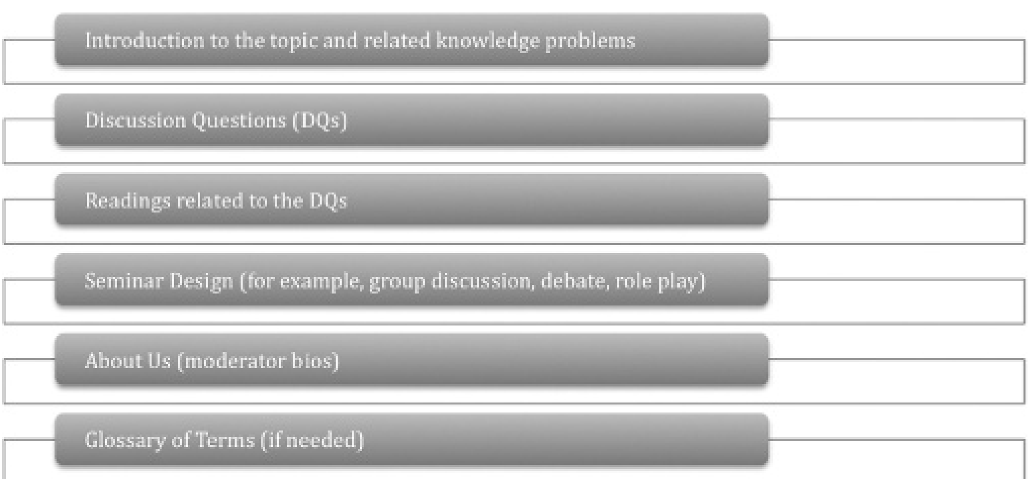


Figure 8.2 Online Seminar Presentation.

Jennifer, Barry, Curt and LeAnne spend considerable time shaping their DQs in relation to what they would like to see discussants accomplish during the seminar. Drafting thought-provoking DQs is a challenge. The team must also seek readings that can help provide discussants with information and data related to the discussions. The team decides to focus DQ 1 on a key problem in the field to stimulate the generating of various ideas or perspectives on the topic. They search for relevant readings. They then teamwork on shaping DQ 2 to encourage the discussants to reflect on the various perspectives that have been generated and identify commonalities among the diverse ideas.

The team is unsure of how to design DQ 3. The final seminar question should lead the discussants to a level of convergence. Jennifer suggests that they bring the seminar to a conclusion by synthesizing all of the discussion into a few points. Curt disagrees, pointing out that it is for the discussants to come to a convergence themselves, not for the moderators to do it for them. The seminar has a fixed timeline, so time is of the essence. Barry suggests using a wiki: "The discussants could each post their position." LeAnne agrees that it would be cool to use a wiki but points out that a wiki does not necessarily encourage convergence. However, using a technique or tool to help discussants come to a final position is a good idea. Jennifer suggests: "What about developing a report card where discussants grade each of the three major options? Or we could have them rate or rank the three options." The team decides that DQ 3 should link to a voting tool whereby discussants vote on the three major options, and provide a brief rationale for their choice. The final decision (and seminar conclusion) would be the majority vote, with dissenting views. With their Presentation completed, the moderators are now ready to launch and facilitate their week-long seminar.

The goal of a good seminar is not unified agreement, but that the discussants learn the analytical language of a field and use the analytical concepts to identify and discuss various perspectives on a topic to arrive at an informed position. Discussants may not agree on one position, and they may agree to disagree. Or, in the case where a single final product is required—as in the case of the team developing three DQs—there is a need to converge on the final product. Whether the conclusion is convergence or consensus, the class has progressed beyond divergence to develop an analytical and informed position.

FACILITATION

It is day one of our team's seminar. They post their Presentation at noon. The seminar is open 24 hours a day for the next 7 days. Already the team is excited to engage in the discussions, but also anxious. What if no one participates? What is taking everyone so long to respond? Are the DQs too difficult or too simplistic? However, it is still early in the seminar: only 1 or 2 hours have passed since the Presentation was posted. Soon the first response arrives: "Great Presentation, Team! The topic is intriguing and I can't wait to get into discussing it. I'll be back online as soon as I do the readings." Another comment is posted and a third and a fourth, and the discussion is launched.

Jennifer, Barry, Curt and LeAnne are encouraged by the participation and camaraderie. They begin to facilitate the comments, to keep the discussion flowing and focused and to help build knowledge about the topic. Facilitating also requires balancing the number, volume and timing of moderator comments. The moderating team must not overwhelm the conference with too many notes, but be active in stimulating discussion, responding to unanswered questions and encouraging others to participate in Idea Generating. They also provide additional questions to either deepen or advance the discussion as needed. Discussants may become too involved in brainstorming; the moderators need to help maintain informed discussion by asking discussants to cite evidence for their views, such as reference the readings and then advance the discussion to initiate convergence, posing facilitating questions such as: What are the key ideas presented? Are there links among them? By acknowledging valuable ideas, and synthesizing or weaving the contributions thus far, moderators can also encourage Idea Organizing. Some students may have begun to reference one another's comments through referencing, and the moderators build upon those initiatives.

Idea Organizing can benefit from weaving, a process of synthesizing the discussions to date, highlighting the important areas covered and suggesting new directions that the discussion might productively cover. Weaving the comments does not mean that moderators should acknowledge each individual's comment, but rather illuminate and highlight the important points made in relation to the DQs and to the topic overall. Encouraging progress from Idea Generating to Idea Organization and on to Intellectual Convergence facilitates the learning process.

Also, the team moderators remind themselves that they are there to facilitate, not to judge or dictate "right" and "wrong." While moderating, they resist the desire to become too involved with the actual debate, keeping in mind that the task is to help each participant to formulate their understanding of the topic with the assistance of the DQs and by facilitating the interaction of the group.

SUMMARY AND TRANSCRIPT ANALYSIS OF THE DISCOURSE

The final portion of the student-led seminar asks moderators to produce a summary of their 1-week seminars, assessing how well their seminar design functioned, level of user activity (volume and pattern of messaging by day, gender, role or other categories) and lessons learned. Moderators also conduct a transcript analysis by categorizing each discussant message as social or cognitive and, if the latter, whether it is primarily Idea Generating, Idea Organizing or Intellectual Convergence. The data are organized by day of the week to plot the number and kind of message each day. The results are input into simple visualization software such as Excel to generate graphic displays such as a line graph showing intellectual change over time.

Scenario Three: Online Global Professional Development Program

Thirty-three participants from 24 developing countries are studying together in an online education course that will last for 8 months. None of these participants have ever engaged in online computer conferencing or online discussion forums. Thirty participants perceive their email usage skills as high, three do not. Most use the internet regularly and report feeling comfortable with computers. The number of male and female participants is almost equal. While many of the participants have computers at home, few have home internet access. As this course is work-related, most of the online discussions and online project teamwork are conducted using workplace computers—usually during the off hours, when the few internet-based computers are not being used by others for work.

This scenario is a fictionalized rendition of a real story involving trade unions. Participants in this course access web-based software, which is based on computer forums (also called conferences) that serve as an asynchronous learning environment to support group discussions, team projects, debates and seminars. Participants enter the learning environment, which is open 24 hours a day, 7 days a week, at any time they want. The system is available worldwide through the internet.

Participants log on to the internet and enter a password-protected environment to access the group activities related to their course. The system organizes the topics into different forums. Users send their messages to the particular forum to which they belong, featuring the topic or unit of that week. When participants log on, they read the messages that others have submitted to the forum and they then reply or post a new message. Messages are organized chronologically.

Figure 8.3 Asynchronous Learning Environment.

Accessing the forums opened by the course instructor, participants log on to text-based "mini-lectures" provided by the instructor and read postings by their peers that relate to the current topic of readings and resources. Participants discuss the topic and, based on the course readings, debate its relevance and consider its application for their first major task.

The course is a non-formal, professional development course for trainers in developing countries. The course curriculum is new to union trainers as is the delivery method. The course comprises four distinct categories of activity:

- seminars based on active reading and discussion of concepts, implications, processes and so on (active reading is when learners are asked to read material with particular, instructor-provided questions to which they must respond);
- seminars based on active reading, as well as discussion and questions and answers;
- technical workshops (learning how to use particular tools);
- teamwork seminars that involve the co-production of a series of documents.

Participants in this particular course live and work in different countries throughout the Caribbean, Africa and the Middle East. The 8-month course is conducted entirely online.

Much about this example is intriguing, including: the geographic span of the participants; the developing world locations; a supportive organization with meager resources and not generally viewed as "on the cutting edge" with respect to innovation or new technology; and the pedagogical design, which involved significant engagement and commitment throughout the 8 months to apply a collaborative approach and knowledge building to solve real-world problems. The collaborativist model continues and grows among union educators in the developing world.

As is the case with learners everywhere, the participants' initial few weeks are characterized by questioning, challenging, brainstorming and divergent thinking: "When I first came across that concept I was skeptical. I wondered what it was about and it left questions in my mind." As other participants begin to share their questions, their experiences and their perspectives, the discussion grows richer. One participant writes: "The volume of material folks are churning out is amazing … we surely have a lot to say and to learn. …" Another writes: "More folks are logging on and asking the right questions and making important and salient points." Participants begin to come together, to converge as a group and start referencing one another by name. "Marc's comments on open source were very valuable and I think that we should ensure that they are included in our first document that we are developing."

Over the first days and weeks, participants each contribute a variety of perspectives and, as they do so, they begin to identify linkages among their ideas and the perspectives offered by others.

Some reflect common viewpoints, others are different. This first round of "Idea-Generating" sessions will not necessarily present final positions but reflects initial positions with widespread differences. Perhaps as a result, almost everyone feels comfortable in offering a perspective. A typical comment is: "I have so far looked at contributions done by many members of the group and they have all presented good cases. … Below is my contribution to the debate." Others also contribute reflections on the issues and input new ideas, but often end with a note such as: "My ideas are not final."

As the discussion continues, it advances in terms of the quality of the debate or exchange. New resources are provided to justify a particular position. Increasingly ideas are linked, either in support of a position or debating another: agreement and disagreement become a stimulus to seek further information, and in some cases to refine one's own position, recant and/or recognize the value of others' input. Ideas are clarified, associations between ideas are identified, and they become clustered into categories.

As with all real problem-solving scenarios, there is a looming deadline for producing a group document. The participants increasingly focus on and move toward Intellectual Convergence, based on shared understanding. Their messages reflect an increase in substantive comments, closure and a framework for co-production of a document. There is also a shift from the use of the pronoun "I" (which categorized the early weeks of discussion) to the use of the pronouns "we" and "our," as the first sessions converge toward co-producing the document.

Intellectual Convergence, it is important to emphasize, does *not* signify a homogeneous conclusion. In fact, Intellectual Convergence is often characterized by conjunctions—but, and, or—reflecting a convergence that is rich with multiplicity. Often, there may be two or three final positions and participants agree to disagree. Intellectual Convergence refers not to acquiescence but rather to the fact that participants now understand the various perspectives proposed in the discussion and how these perspectives relate to one another. In the case of co-productions, convergence reflects a consensus or it may represent a range of conclusions.

A remark often made is: "I just want to add this because, like Anikka, I share the views of everyone so far." Closure is evident in this comment: "Frankly I am very impressed with the ability to pull all the varying comments and suggestions into the document and make sure that you captured everyone." Signing off, another participant writes: "I think that we have all done brilliantly so far. Thanks for all your comments and input … I do believe that we are a great team and group."

Scenario Four: Online Educational Games and Immersive Learning Environments

Virtual video games are immensely popular among youths and adults. Estimated numbers of players are in the hundreds of millions. One of the most popular online multiplayer games is *World of Warcraft*, a fantasy game with over 10 million current subscribers, of which 2.5 million are in North America. Educational applications of online video games also have tremendous appeal in the market, although many educators and parents are skeptical about the educational benefits. There is justification for skepticism, but emerging research, as well as new developments in online educational games, is providing evidence of positive potential for learning. While educational video games are not a magic bullet, teachers and researchers report powerful learning possibilities in games with well-designed pedagogies.

Online educational multiplayer games such *Food Force*, produced by the United Nations (UN) to educate users on food aid distribution through the use of online role plays, gained 1 million players in the first 6 weeks, 4 million players in the first year and is now available in 10 languages, according to the UN. The game contains six different missions for players, who are faced with a number of realistic challenges. In a race against time, they must feed thousands of people in the fictitious island of Sheylan: they pilot helicopters, while looking out for hungry people; negotiate with armed rebels blocking a food convoy; and use food aid to help rebuild communities. *Food Force* is designed especially for classroom use and offers teaching resources as part of the lesson plans. It can be downloaded without cost.

Online games are typically multiplayer in design, meaning that problems are set up to be solved collaboratively by teams. The online game *Whyville*, oriented to K–12 math and science education, has 4 million subscribers (90% are North American), with the dominant demographic being 8–14-year-old girls (Mayo, 2009). Teachers and educational researchers report positive outcomes. One teacher on the site reports that

> My sixth graders love it! *Whyville* supports the use of computers by kids the way that scientists use computers: for data collection, data visualization, simulation and modeling and scientific communication. The site also reflects what we know about learning communities and the kinds of interaction kids seek while learning and having fun.

Others who have left comments on the *Whyville* site include Joan Korman, author of *Internet Resources for Women* and Professor of English, University of Maryland, who writes:

> *Whyville* is an imaginative web site that aims to help elementary, middle, and high school students understand and enjoy science. It differs dramatically from most science education sites in its use of avatars, games, computer simulation and modeling, a *Whyville* newspaper, and interactivity among *Whyville* participants. Though *Whyville* is not designed specifically for girls, girls make up more than 60% of its users, an exceptionally high percentage for a science-and-technology-focused site. (Whyville.net)

Another collaborative, virtual environment for use in school classrooms is *River City*, which uses lifeforms or avatars something like those in *Second Life*. *River City* is targeted at students in grades 6–9 and portrays how three diseases simultaneously affect health.

The National Science Foundation funded *River City* multiuser virtual environment is centered on skills of hypothesis formation and experimental design, as well as content related to national standards and epidemiology. Students learn to behave as scientists as they collaboratively identify problems through observation and inference, form and test hypotheses and deduce evidence-based conclusions about underlying causes. Collaborating in teams of three or four participants, they try to figure out why people are getting sick and what actions can remove sources of illness. They talk to various residents in this simulated setting, such as children and adults who have fallen ill, hospital employees, merchants and university scientists (Dede, 2009, p. 67).

More highly sophisticated game content exists. An example is the games developed by the Federation of American Scientists on such topics as immunology. In *Immune Attack*, the player controls drones that activate the release of immunity enzymes (for more information on this game, see http: fas.or/immuneattack).

Researchers studying online games have found promising results for the importance of pedagogy. Good pedagogy leads to positive educational outcomes, while weak pedagogical design in the software yields poor results. Mayo's (2009) review of the research literature on gaming notes that "where learning benefits appear, they are attributed to effective pedagogical practices embedded in the game design" (p. 80). The collaborative learning pedagogy has increased student engagement and conceptual change. Multiplayer game-based activities require students to work in teams to form a hypothesis, experiment with various options and come to an Intellectual Convergence on which actions to take and then the consequence of those actions.

Figure 8.4 *River City* Multiuser Virtual Environment.

Mayo (2009) raises an interesting point about the importance of pedagogy: she notes that students in a typical classroom ask 0.11 questions per hour, whereas educational games offer constant interaction—almost each keystroke yields a response. The active participatory nature of gaming is a vast departure from traditional passive lecture learning. Researchers describe a near universal antipathy to the undergraduate lecture format: 98% of students who leave science and engineering majors and 86% of those who stay report "poor teaching by faculty" (Seymour & Hewitt, 1997) to be a major concern. Mayo cites a meta-study of 6,542 students in 62 introductory physics classes that found "switching to any interactive mode of instruction (for example, group projects, Socratic lectures and participatory demonstrations) easily improved learning outcomes in introductory physics by 108 percent" (2009, pp. 80–81). She also reports that other studies have found that video games can yield a 7% to 40% improvement in learning over lectures (Mayo, 2009).

Immersive learning environments are another feature of some video games, in which the user assumes an online persona and engages in a realistic, digitally enhanced setting, a 3-D virtual world.

> Immersion is the subjective impression that one is participating in a comprehensive, realistic experience. Interactive media now enable various degrees of digital immersion. The more a virtual immersive experience is based on design strategies that combine actional, symbolic, and sensory factors, the greater the participant's suspension of disbelief that she or he is "inside" a digitally enhanced setting. (Dede, 2009, p. 66)

Dede reports that immersive interfaces aid in designing educational experiences that yield valuable results for learning: digital fluency, engagement and learning and transfer from classroom to real-world settings. Learning is enhanced through the multiple perspectives enabled by the immersive interface, the situated learning and improved transfer from the classroom to the real-world context (2009, p. 67).

Online video games for learning are used by many disciplines in schools, universities and training settings. Immersive simulations are also used in corporate and military settings. One of the most successful, and the earliest educational immersive simulation, was developed for pilot training. Today, airplane flight and surgical simulators demonstrate a highly successful transfer of learning from the educational setting to real-world application.

Research has demonstrated that visual skills developed by video games have implications for training in the case of laparoscopic surgery. Greenfield (2009, p. 70) notes that

> surgeons recognize that laparoscopy has changed the required skill profile of surgeons and their training needs. In laparoscopic surgery, a small incision is made, and a viewing tube with a small camera on the eyepiece is inserted through it. The surgeon examines internal organs on a video monitor connected to the tube and can also use the viewing tube to guide actual surgical procedures. Navigating through and operating in a three-dimensional space represented on a two-dimensional screen with minimal tactile feedback constitute basic parallels between laparoscopy and action video games. A study of the relation between video game skill and success in training for laparoscopic surgery yielded positive results: Action video game skill (as demonstrated in the laboratory) and past video game experience (assessed through self-report) predicted laparoscopic skills; in contrast, neither laparoscopic experience in the operating room nor years of training significantly predicted laparoscopic skill. The best game players (the top third) made 47% fewer errors and performed 39% faster in the laparoscopy tasks than the worst players (the bottom third). These results indicate the value of video game play as informal educational background for specific training in laparoscopic surgery, a finding that is applicable to other lines of work (such as piloting a plane) whose skill profiles overlap with those required by action video games.

Summary

Chapter 8 introduced a discussion and description of collaborativist (previously known as online collaborative learning or OCL) pedagogies in practice. The chapter focused in detail on four pedagogic scenarios taken from real educational applications: online simulations and case studies of virtual organizations; student-led online seminars; co-production of real-world products and programs; and online educational games and immersive learning environments.

Four virtual students were introduced as examples to depict the experiences of learners in the first two scenarios. The level of detail provides in-depth illustration of how online pedagogies might function in real-world contexts.

9

Collaborativist Scenarios

Online Communities of Practice

What counts as scientific knowledge, for instance, is the prerogative of scientific communities, which interact to define what facts matter and what theories are valid. There may be disagreements, there may be mavericks, but it is through the process of communal involvement, including all the controversies, that a body of knowledge is developed. It is by participating in these communities—even when going against the mainstream—that members produce knowledge.

—Wenger, McDermott and Snyder, 2002

Chapter 9 examines online communities of practice and presents the following topics:

- Context and definition of key terms such as:
  - Community
  - Communities of practice
  - Community of learning
  - Social networks
  - Online communities
- Definition of an online community of practice (OCoP)
- History of OCoPs
- Two OCoP exemplars:
  - Global Educators' Network (GEN)
  - Wikipedia
- An analytical framework to study and design OCoPs.

Context of Communities of Practice (CoP)

Chapter 9 addresses a fascinating and key aspect of human learning—informal learning in online communities of practice (OCoP). Informal learning refers to experiential learning, that is, learning outside of the classroom. There is no teacher or curriculum; nor is there a degree, diploma or certificate as a result. Informal learning is the way that we learn throughout our lives. We learn by doing, by observing and by experiencing life. As professionals, we hone and advance our knowledge through experience and informal learning with peers and experts in our field. It is commonly asserted that informal learning constitutes around 80% of the learning in organizations (Cross, 2007, p. 17). With the advent of the internet, online communities have become a new, important and highly popular destination for informal learning and knowledge building, as well as for social communication.

Chapter 9 builds on Chapters 6, 7 and 8 by examining the role and significance of OCoPs. The chapter provides definitions and presents two real-world examples to depict how OCoPs function and contribute to learning and knowledge building. Chapter 9 concludes by discussing features and indicators of OCoPs and puts forward a Framework for Analysis to assist the design, implementation and assessment of OCoPs.

It is illuminating that the terms "communication" and "community" derive from common Latin roots, *communicare* and *communis*, which mean "to share." Sharing has enabled humans to survive and to thrive, and, as discussed in this book, has been the basis of civilizational advances. The ability to intentionally collaborate defines the fundamental nature of the human species (Hrdy, 2009). From the days of our earliest ancestors, the ability to communicate and to form communities has been key to our survival. Communication is at the heart and soul of human development, individual and social. And in fundamental ways it is key to how we learn.

Moreover, the concept of the community is replacing the image of the solitary genius as the sole, primary or even preferred source of creativity, science and innovation (Farrell, 2001). In studying the major artistic, social and scientific transformations of the past two centuries, Farrell notes that "artists, writers, composers, scientists, social reformers and other creative people report that a collaborative circle played an indispensable part in their development" (2001, p. 1). He cites a passage from the American writer Henry James, who suggests that without a community of peers, creative work is far more difficult:

> The best things come … from the talents that are members of a group; every man works better when he has companions working in the same line, and yielding to the stimulus of suggestion, comparison, and emulation. Great things have of course been done by solitary workers, but they have usually been done with double the pains they would have cost if they had been produced in more genial circumstances. (James, 1909, p. 31, quoted in Farrell, 2001, p. 1)

Lave and Wenger (1991) coined the term "communities of practice" in the context of studying traditional apprenticeship. As Wenger later noted:

> Apprenticeship is often thought of as a relationship between a master and a student. Yet we observed that learning took place mostly during interactions with journeymen and more advanced apprentices. Community of practice is the term we used to refer to this social structure. Once we had the concept, however, we started to see these communities in many other settings, where there was no official institution of apprenticeship. (Wenger, McDermott, & Snyder, 2002, p. 233)

The concept of communities of practice (CoP) has been adopted in education, training and management as well as in related fields. The term refers to relatively tightly knit groups of professionals engaged in a common practice, who communicate, negotiate and share their best practice with one another directly. Sometimes these professionals work in the same organization. More typically, CoPs exist outside of a particular workplace, but within a particular profession or area of skill. For example, high school biology teachers may participate in a CoP related to their specialization, even though they teach in different schools in different cities or countries. Heart surgeons may travel long distances to study one another's work and learn new techniques from peers or experts in the field.

CoPs may also be composed of hobbyists or interest groups. They may be antique car enthusiasts, foodies or self-help groups such as people who share news and information to learn more about their particular concerns and deepen their knowledge on that topic. Most of us belong to various CoPs; we may be very active in some of these communities while we participate only occasionally in others.

> Communities of practice are groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis. … These people don't necessarily work together every day, but they meet because they find value in their interactions. As they spend time together, they typically share information, insight and advice. They help each other solve problems. They discuss their situations, their aspirations, and their needs. They ponder common issues, explore ideas, and act as sounding boards. They may create tools, standards, generic designs, manuals, and other documents—or they may simply develop a tacit understanding that they share. However they accumulate knowledge, they become informally bound by the value that they find in learning together. This value is not merely instrumental for their work. It also accrues in the personal satisfaction of knowing colleagues who understand each other's perspectives and of belonging to an interesting group of people. Over time, they develop a unique perspective on their topic as well as a body of common knowledge, practice and approaches. They also develop personal relationships and established ways of interacting. They may even develop a common sense of identity. (Wenger et al., 2002, pp. 4–5)

CoPs not only accumulate knowledge, they also contribute to advancing knowledge. Solving new problems and documenting the solution in a manual, article, new way of working or new tool represents a knowledge artifact. Barab, MaKinster and Scheckler (2004) note that participation in a CoP:

> results in some outcome, whether it is an idea, a tool, drawing, online post, or simply becoming more knowledgeably skillful with respect to the practice. This process of transforming experience and the outcomes of experience into a thing is known as *reification*. (p. 66; emphasis in the original)

The construction of a knowledge artifact is a very important phenomenon and output of practice, but there is a danger associated with reification that Wenger (1998) also addresses:

> Reification as a constituent of meaning is always incomplete, ongoing, potentially enriching, and potentially misleading. The notion of assigning the status of object to something that is really not an object conveys a sense of mistaken solidity, or project concreteness. It conveys a sense of useful illusion. The use of the term reification stands both as a tribute to the generative power of the process and as a gentle reminder of its delusory perils. (p. 62)

Knowledge is thus an outcome or a product, but it is also part of human practice. It is not just a “thing”; it is formed by communities and reification of practice. A tool or a book is most relevant to and understood by the communities associated with the practice represented by that artifact. Members of the community are most likely to understand a particular new tool or book. Attempts at knowledge management, to make knowledge into a static “thing” like a self-contained entity through the use of databases or other forms of IT, have proven elusive or challenging at least. Wenger et al. (2002) argue that knowledge should not be viewed as a static object and suggest several points related to the challenge of creating usable knowledge. They write:

> **Knowledge Lives in the Human Act of Knowing**
> … The knowledge of experts is an accumulation of experience—a kind of “residue” of their actions, thinking and conversations—that remain a dynamic part of their ongoing experience. This type of knowledge is much more a living process than a static body of information. Communities of practice do not reduce knowledge to an object. They make it an integral part of their activities and interactions, and they serve as a living repository for that knowledge.
>
> **Knowledge is Tacit as Well as Explicit**
> … Communities of practice are in the best position to codify knowledge, because they can combine its tacit and explicit aspects. They can produce useful documentation, tools, and procedures because they understand the needs of practitioners. Moreover, these products have increased in meaning because they are not just objects by themselves, but are part of the life of the community.
>
> **Knowledge is Social as Well as Individual**
> … Appreciating the collective nature of knowledge is especially important in an age when almost every field changes too much, too fast for individuals to master … this collective character of knowledge does not mean that individuals don’t count. In fact, the best communities welcome strong personalities and encourage disagreements and debates. Controversy is part of what makes a community vital, effective, and productive.
>
> **Knowledge is Dynamic**
> … In short, what makes managing knowledge a challenge is that it is not an object that can be stored, owned, and moved around like a piece of equipment or a document. It resides in the skills, understanding, and relationships of its members as well as in the tools, documents, and processes that embody aspects of this knowledge. (Wenger et al., 2002, pp. 9–11)

CoPs are also represented in academic and professional fields, such as the pure and applied sciences, computer science, education and arts. Kuhn (1970) posited that scientists work in disciplinary communities and, through discourse (discussion, debate), generate the current state-of-the-art knowledge in that discipline. Bruffee (1999) used the term “knowledge communities” in a similar way. Disciplinary communities of scientists, artists and other professionals are the means of generating and advancing knowledge in their respective fields. Correspondence, books, tools or manuals that document processes, within the context of the field or discipline, not only reify but diffuse the knowledge among peers, inductees, apprentices and students.

Scientific advances depend on the speed and efficiency of communication. A scientific community interacts across time (even over generations) and geography. Historically, knowledge has

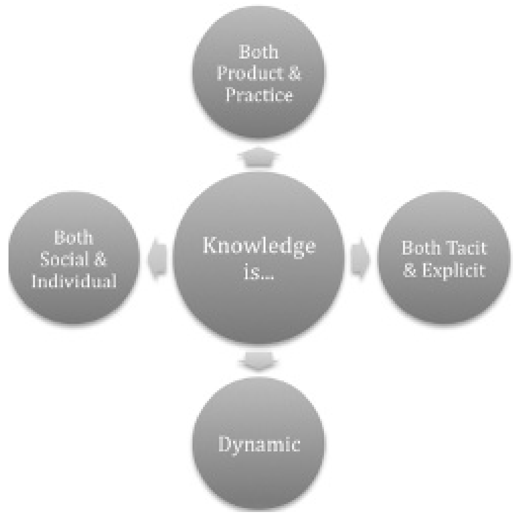


Figure 9.1 Knowledge in Communities of Practice.

advanced as communication technologies have improved. This was demonstrated with the role of the printing press, which, together with the rise of the early postal service and inventions in transportation, accelerated the development of modern science from the 16th century (the time of Galileo) until today. Informal systems of communication such as meetings, letters and scholarly publications, which form the "nervous system" of science, were refined and improved. Scientific researchers communicated more often, more widely and thereby more intensively in their area of specialization. Scientific communities comprised specialists working in "invisible colleges" (meetings, publications, personal correspondence, reports). As the mechanisms to meet and share ideas improved, so too did scientific knowledge.

Brown and Duguid (2000) note the importance of text and documents in generating new schools of thought and practice. They portray the history of the internet as extending a long tradition of communities that formed around documents: textual communities. Schools of thought and practice, they argue, are based on shared texts. "The shared texts as much as anything else gave texture to the notion of a discipline, a profession, or an interest group, though most of the people in these 'worlds' knew little of one another directly" (Brown & Duguid, 2000, p. 190). The antecedents of CoPs actually go back much further than textual communities, to the dawn of humanity. Wenger et al. (2002, p. 5) write:

> Communities of practice are not a new idea. They were our first knowledge-based social structures, back when we lived in caves and gathered around the fire to discuss strategies for cornering prey, the shape of arrowheads, or which roots were edible. In ancient Rome, "corporations" of metalworkers, potters, masons, and other craftsmen had both a social aspect (members worshipped common deities and celebrated holidays together) and a business function (training apprentices and spreading innovations). In the Middle Ages, guilds fulfilled similar roles for artisans throughout Europe. Guilds lost their influence during the Industrial Revolution, but communities of practice have continued to proliferate to this day in every aspect of human life.

Definitions of Key Terms

It is important to distinguish CoPs from similar but different concepts such as communities in general, communities of learning, task-oriented communities (work teams and project groups) and social networks. We will also briefly discuss the notion of *online* community.

Community

The concept of community is a difficult term to define because of the very wide and diffuse use of the term. While the term "community" may seem like a simple concept that refers to people who live in the same geographical area, there are in fact hundreds of distinct scholarly and popular definitions. For our purposes, we set out a simple but succinct definition of how the term is commonly used:

> [A] self-organized network of people with common agenda, cause, or interest, who collaborate by sharing ideas, information, and other resources. Virtual communities consist of participants in online discussions on topics of mutual concern, or of those who frequent certain websites. (www.businessdictionary.com/definition/community.html)

Communities of Practice (CoP)

The term "community of practice" has evolved from an emphasis on apprenticeship within an organization to that of members sharing a common profession or type of work beyond an institutional affiliation. In fact, the latter is the most common understanding of CoP: shared profession or work but not shared workplace. CoPs are informal, meaning that they are voluntary and not mandated or assigned by a workplace or organization. In the extract below, Wenger et al. (2002) provide a broad description of CoPs, which includes communities of non-professional practice such as those related to hobbies as well as communities based on professional practice.

> Engineers who design a certain kind of electronic circuit called phase-lock loops find it useful to compare designs regularly and to discuss the intricacies of their esoteric specialty. Soccer moms and dads take advantage of game times to share tips and insights about the subtle art of parenting. Artists congregate in cafes and studios to debate the merits of a new style or

Figure 9.2 What is a Community?

> technique. Gang members learn to survive on the street and deal with an unfriendly world. Frontline managers running manufacturing operations get a chance to commiserate, to learn about upcoming technologies, and to foresee shifts in the winds of power. (p. 4)

CoPs are those in which members share or develop several core commonalities. Members typically share: a common language or set of terms related to their profession, practice or interest; a substantive common focus; a common set of problems; common training or experience; a common way of working or doing things; a common set of tools or technologies; and a common tacit understanding of the topic. CoPs also contribute to learning and to building knowledge, whether this goal is implicit or explicitly stated. Some CoPs reflect an intense passion or urgency to solving problems. Others are more oriented to social interaction. Nonetheless, there is generally a high level of cohesion and intentionality if the group is to survive. CoPs with weak bonds, low levels of interaction or lack of relevant knowledge and experience typically do not attract new or sustained membership. Most CoPs reflect a mixture of problem-solving and socializing discourse. CoPs that specifically and intentionally commit to building the field of knowledge are most typically associated with scholarship, research, science, new technologies, new forms of artistic and cultural expression or social activism.

Community of Learning

A community of learning is frequently associated with an educational program or course, guided or established by an instructor and linked to the curriculum of studies in some way; it can thus represent formal or non-formal learning. The instructor will induct students into learning communities as part of their course or program of studies. Most often, a community of learning is related to accomplishing an assigned task or project, and is thus similar to a work group or project team. The topic, tasks and timeline are set by the instructor. Membership is mandated by the instructor, whether the instructor selects the team members or students self-select which group to join. A community of learning is neither voluntary nor ongoing.

> The learners' community is not perennial because its members are not engaged in a durable way in the activity at the base of its creation. It is born, grows, and dies at the rhythm of the stages of an educational program. In this aspect, it does not share the continuous activity that characterizes the community of practice in the work environment. (Henri & Pudelko, 2003, p. 481)

Communities of learning for educators are most typically associated with professional development courses, training activities or educational programs.

Work Teams or Project Groups

Work teams or project groups are typically mandated by an organization to accomplish a specific task within a specified period. The members do not participate voluntarily but are recruited or assigned to meet a particular need within the framework of the organization or workplace. The task, the membership and the terms of work are set by the organization. A work team exists for a specific period and then dissolves. In the case of project-based teams related to research, the team may regroup or continue if further funding (external or institutional) is found.

Social Networks

A social network refers to a set of social relationships, with the emphasis on the relationship and not on a particular topic or substantive focus. Social networks are voluntary and informal.

Online Communities

The term online community is used throughout this book to mean the same as virtual communities and e-communities. These terms can generally be used interchangeably. An online community is any community that exists in a web-based environment, such as forums or social networks.

The internet has been referred to as a vast online world, or set of online worlds and communities. Today, hundreds of millions of people participate in online communities and social networks—and these people view these worlds or virtual spaces as real, as authentic. Their experience is one of communicating and interacting with other real people, and while some may use pseudonyms or playful user IDs, most participate by using their real names or email IDs. It is thus important to recognize that online communities and online learning applications are real: they are not false or inauthentic forms of human interaction. Participant engagement varies depending on the task or nature of the community: an online hobby community may be less intense than an online community of professional practice—or it may be equally or even more intense and engaged. The level of participation may vary; the duration of the activity or the expectations or requirements of participation may vary. However, the perception of authenticity is that one is really participating, and the online experience can equal or exceed that of a real-time face-to-face event or community, even in online text-based communities.

A second aspect of online worlds, however, relates to some form of performance based on creativity, imagination, identity and embodiment of a character or role. For example, Sherry Turkle's book, *Life on the Screen* (1995), presents a view of the internet as an exciting and creative space where virtual identities can be constructed and experimented with. Each online community and multiuser game has its own culture and rules of behavior: it may encourage the use of role play, variations on how the self can be portrayed and presented and/or anonymity or pseudonyms. Some online communities of interest as well as online games may allow or even encourage anonymity or pseudonyms. Many online special interest groups (SIGs) and hobby groups are not particularly concerned with representation of self, as long as the user abides by the norms and etiquette of that "space." Similarly, many games and immersive worlds are premised on the construction and use of online personas. The early examples of immersive worlds, derived from online text-based multiuser games such as MUDs (multiuser dungeons and dragons, later renamed *mu*ltiuser *d*omains) and MUSEs (*mu*ltiuser *s*imulated *e*nvironments), expected and encouraged exploration or online personas and new behaviors and interactions.

While such use of online personas does not necessarily reflect inauthentic communication or misrepresentation, it is not the focus of this chapter and communities based on games, arcade role plays or multiple representations of self are not considered here.

What is an Online Community of Practice?

An online community of practice (OCoP) shares all of the features of a traditional community of practice (CoP), but it is conducted via the internet rather than onsite through face-to-face communication. The nature of the technology that mediates each type of CoP introduces different affordances. That is, the commonalities shared by members of a CoP are the same for an OCoP but the means of sharing and interacting have differences that can be significant. Face-to-face communication enhances some aspects of the communication but limits others; online communication similarly offers certain strengths and limitations. The internet, for example, enables far greater scope and scale of interaction and discourse than face-to-face meetings because of attributes such as place-independent, time-independent, many-to-many, text-based communication. On the other hand, the expanded access available online can also introduce potential disadvantages such as communication overload from a large number of participants or postings. The attributes of online collaboration were discussed in Chapter 7, and that discussion is applicable to online communities as well.

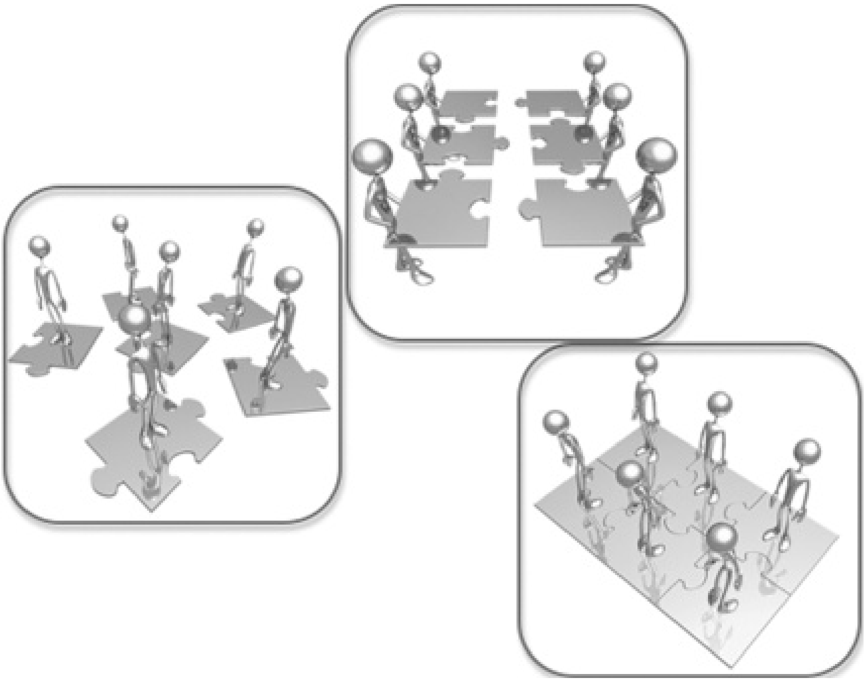


Figure 9.3 Three Conceptualizations of an OCoP.

CoPs, as noted by Wenger et al. (2002), have been part of human development since we lived in caves as hunters and gatherers. And they remain integral to our lives today. What is amazing, however, is the degree to which CoPs have populated the online world.

History of Online Communities of Practice

As discussed in Chapter 2, the invention of the internet itself was the product of CoPs. The inventors were computer scientists who first worked together onsite and then, once the technology was invented and implemented, continued to work together online. And the internet has gone on to support millions of online communities, users' groups and social networks.

The internet is characterized by an immense quantity, quality and range of online communication. Email has the highest number of users of all internet applications, and online communities and social networks are close runners up. Online communities emerged during the 1970s, and their numbers snowballed from the 1980s. Scientists, academics, educators, professionals—all those who had access to computers and the network—soon began forming CoPs online.

Bitnet, the academic predecessor to the internet, was an early world leader in network communications for the research and education communities, and helped lay the groundwork for the subsequent introduction of the internet, especially outside the US. The international Bitnet network (the "Because It's Time" network) began in the spring of 1981. Bitnet users shared information via electronic mail to individuals and shared-interest groups. Nearly 3,000 discussion groups on Bitnet covered topics of academic interest, from butterfly biology to theoretical physics, usually filtered and approved by a human moderator, and supported by the listserv software. Membership in an online community was anywhere from five participants to several thousand. The discussion groups based on mailing lists were the most popular elements of Bitnet.

Online communities based on computer conferencing systems or forums such as the west coast Whole Earth 'Lectronic Link (the WELL) emerged and became highly active in the 1980s, leading to online friendships and even marriages, as documented by Howard Rheingold's 1993 book, *Virtual Communities*. Online collaborative games such as MUDs and MUSEs emerged in the late 1980s and proliferated, providing members with programming tools to create new online worlds, societies and situations. Educators in the 1990s adopted multiuser environments for educational applications in their classrooms: for example, students might design and participate in an online world based on certain political or social principles (democracy, feudalism, dictatorship), assuming various roles within this online world. Or students might become pioneers in settling a new planet, scientists experimenting with research or environmentalists solving important problems. Such experiences then led to class discussion and analyses.

By the 1990s, millions of users participated in online academic, professional, educational, technical, political, social, special interest and/or hobby-related communities or discussion groups. User-generated online content became well established in educational applications such as online university courses, networked classrooms, online educational game communities and OCoPs (see Hiltz & Turoff, 1978; Harasim, 1993; Riel, 1993; Harasim et al., 1995; Palloff & Pratt, 1999, 2003).

Thus, the rise of Web 2.0 and its designation as the "social" web should neither detract from nor diminish our understanding and appreciation of the tremendous social role played by the early Arpanet and internet in terms of communication, networking, online communities and collaborations and user-created content in the 1980s and 1990s.

The development of Web 2.0 group collaboration tools such as social networks, texting, Twitter, cultural production tools (YouTube, Flickr) and blogs since 2004 has built upon generations of online communities that first began in the 1970s. The computer conferencing system invented by Murray Turoff in 1972 was expressly aimed at facilitating group (many-to-many) communication, to expand and enhance electronic mail (email) invented in 1971 to facilitate one-to-one and one-to-many communication. And the earliest users of computer conferencing were professionals who employed this medium for professional discourse, problem-solving, knowledge building and general communication associated with their professional practice (Hiltz & Turoff, 1978). Email lists, bulletin boards, computer conferencing systems, discussion forums, synchronous chat lines and environments such as MUDs and MUSEs were technologies that supported online communities from the mid-1970s, and many continue to be used today.

At the same time, Web 2.0 has definitely drawn public attention to online social communication and collaboration, and provided new collaboration tools and platforms that have been adopted by OCoPs.

OCoPs have also begun to generate significant interest by educational researchers. Lave and Wenger's (1991) concept of CoPs was initially related to studies of workplace learning and apprenticeship and then expanded to include both professional communities and communities of interest (hobbyists, for example). Riel and Polin (2004) focus on learning communities and identify three distinct but overlapping types: task-based, practice-based and knowledge-based online learning communities. They define task-based learning communities as "groups of people organized around a task who work intently together for a specific period of time to produce a product" (p. 20). A practice-based learning community refers to a larger group "with shared goals that offer their members richly contextualized and supported arenas for learning" (pp. 20–21). Knowledge-based learning communities "often share many of the features of a community of practice but focus on the deliberate and formal production of external knowledge about the practice" (p. 21). Henri and Pudelko (2003) discuss four types of virtual communities: communities of interest (people assembled to share ideas about a common topic); goal-oriented communities of interest (comparable to a task-force or project team vested with a specific mandate); a learners' community (guided by an instructor and linked to curricular objectives); and communities of practice (members share and pool complementary knowledge to enrich one another's professional practice).

Exemplars: How Do OCoPs Function?

A key question relates to how CoPs become successful and, more fundamentally, what does "successful" mean in the context of OCoPs? What constitutes success in terms of participation, and particularly in terms of collaboration, learning and knowledge building? How are successful OCoPs launched, structured and sustained?

These are fascinating and profound questions. As Barab, Kling and Gray (2004) noted:

> Too little of the education literature provides clear criteria for what does and does not constitute community; the term is too often employed as a slogan rather than as an analytical category. We also know little about the educational value of employing a community model for supporting learning. (p. 3)

Moreover, as these and other authors note, it is relatively easy to start an online community. At least in terms of technology, we have free access to listservs, computer conferencing systems and discussion boards, and more recently users have used blogs, wikis and social networks such as Facebook to start online communities. However, even by the early 1980s, there were discussions about "what to do if you host an online community and nobody shows up?" The internet is littered with dead and abandoned online communities and SIGs.

It is not just launching an OCoP but building and sustaining it that is a significant challenge, especially if the task is knowledge construction. Thus, important questions must be posed. As Barab, Kling and Gray (2004, p. 4) state: "Building online communities in the service of learning is a major accomplishment about which we have much to learn." We must ask whether the OCoP is succeeding and what exactly it is accomplishing. We must also explore how we can define and determine success. And what designs, structures, processes and tools can best support success. These are critical questions and suggest areas for research and development.

This chapter sets out two case examples of OCoPs and identifies some of the indicators of success that were reported, as well as the processes and tools involved, as a contribution to further research in this area. The two cases are:

1. the Global Educators' Network (GEN);
2. Wikipedia.

For our purposes, the term "online communities of practice" (OCoPs) will be viewed as encompassing the voluntary association online of professionals, practitioners, scientists and/or interest groups who come together intentionally, actively and regularly for mutual gain and collective value. Typically, the members of an OCoP share a common background based on work, practice or interest and, associated with that practice, common values, tacit understanding, common terms or language, exposure to common problems and common experience and/or training. Members will also share common purpose or intentionality for their OCoP, of which learning and building knowledge may be implicit or explicit.

The two OCoPs described below are drawn from real-world practice. They reflect examples of informal learning and thus exclude online formal education (which was the subject of Chapter 7) and online non-formal education (the subject of Chapter 8). Both examples represent intentional collaboration, learning, sharing of information and the building of knowledge but each case does so in a different way and with differing emphases. While many OCoPs exist related to educational professions, we draw upon examples that have been studied and have generated empirical data.

Global Educators' Network (GEN)

The Global Educators' Network (or GEN) was an online community created "for online educators, by online educators." GEN was an international informal learning network aimed at encouraging information exchange, learning and knowledge building on the subject of online learning. Launched in 1999, GEN was based on asynchronous group communication using the web-based Virtual-U software. GEN began as a way to link a small group of educators and researchers involved in research projects focused on online learning, and then grew rapidly as educators from around the world learned of it and asked to join the discussions. As membership grew, a tool to enable self-registration to the online forum was developed and implemented. GEN soon evolved into an online community autonomous of the original research project but maintaining links that were considered mutually beneficial (these links are described below). Membership and participation in GEN were voluntary, and within 2 years membership grew to 2,400 members from 75 countries, reflecting users with various backgrounds and levels of expertise in online education. Members included K–12 teachers, trainers, university faculty, graduate students, software developers and educational and computer science researchers.

GEN became an OCoP with the goals of sharing best practice, encouraging collaborative learning related to online education and building and advancing knowledge in the field. The social design of GEN changed over time and in response to increased membership and active participation, from topical freeform discussions into an ongoing series of monthly seminars, moderated by the members. GEN members would volunteer to moderate a seminar on a topic of their choice; initially a seminar would be 2 weeks long, but they expanded to become 3 weeks in duration.

The seminars involved online peer collaboration linking conceptual learning with real-world problems and questions. GEN seminars often produced knowledge artifacts that synthesized the knowledge of the group on particular topics. Archives were one form of artifact, but summaries, wikis and resource lists were also produced by GEN members and circulated to other forums or disseminated to other practitioners through various means.

A GEN coordinator offered moderating tips and support through an online "metaconference" established for each seminar. Moderating suggestions also became "reified" into online documents available for members.

The design and goal of the GEN community evolved quickly as its size grew. The monthly seminar series became the backbone of the online community, since all members were automatically registered. A number of additional online activities also emerged: reading groups, an ecafé for socializing, SIGs and groups engaged in special projects.

The relationship between GEN and the research projects was relatively informal, in that the GEN community provided feedback on the social and pedagogical designs, content and membership. GEN did, nonetheless, benefit from the research project. At the practical level, funding was provided to hire a part-time coordinator to help manage GEN. Her role was to welcome new members, provide basic training in participation and moderating of the online discussions, troubleshoot and provide technical assistance. She also coordinated volunteers who were interested in moderating the online monthly seminars. With regard to the research activities, GEN members had ongoing opportunities to learn about the latest research findings and also to discuss and debate with researchers who were either directly involved in the research projects or were researching similar topics elsewhere.

The research project also benefited from GEN. GEN user feedback informed ongoing social and technical design of the online educational environment of the Virtual-U software, with respect to collaborative learning in an online environment, community and knowledge building. GEN was an opportunity to learn about and study online communities of educational practice, both by members and by researchers. In addition, GEN also assisted in the dissemination of research findings related to online learning and, on occasion, served as a sounding board for new research ideas.

CONTEXTUAL INDICATORS (QUANTITATIVE DATA) OF SUCCESS

The key indicator of success for any OCoP is basic: is it alive and is it well? The pulse of an OCoP is the level of member activity and participation, and this can be determined through quantitative data. Relatively basic and accessible usage data can provide an insight into the life of the community, while qualitative indicators related to social and intellectual activities can illuminate its well-being.

Quantitative and qualitative data provided valuable insights into the level and nature of activity and participation. The Virtual-U software, which provided the GEN platform, was customized to automatically generate a variety of usage statistics to help users, moderators and researchers to monitor and view participation from various perspectives. For example, usage statistics indicate the number of seminars, the number of members, the change in membership numbers per month and level of activity overall as well as in specific categories. Usage data were also automatically generated by the system for each seminar, such as the number of messages in a seminar, number of messages *written* per participant, number of messages *read* per participant, number of messages posted per day and the number of new messages versus replies. Views of each seminar can be organized by date, by sender or by message threads. These data provide a valuable snapshot of which seminars had the most active participants, which generated the most comments, the level of interaction and replies and the topics covered by threads. Analysis of message threads in each seminar provided an overview of the flow and development of a topic: showing which thread generated the most (and the fewest) comments and the scope of topics covered in a seminar.

SOCIAL AND INTELLECTUAL INDICATORS

The value of an OCoP such as GEN is the quality of its social and cognitive discourse. Discourse can be studied in online communities. The transcripts of the online text-based discussions are automatically recorded and archived by computer conference, blog or forum software and can be retrospectively studied (given participant consent). Three major types of discourse were analyzed:

1. social discourse;
2. intellectual discourse;
3. moderator discourse.

SOCIAL DISCOURSE ANALYSIS

The social nature and value of GEN for the members was studied by examining the transcripts of the seminars. Three subcategories of social discourse were examined:

a. community building;
b. social engagement;
c. user satisfaction.

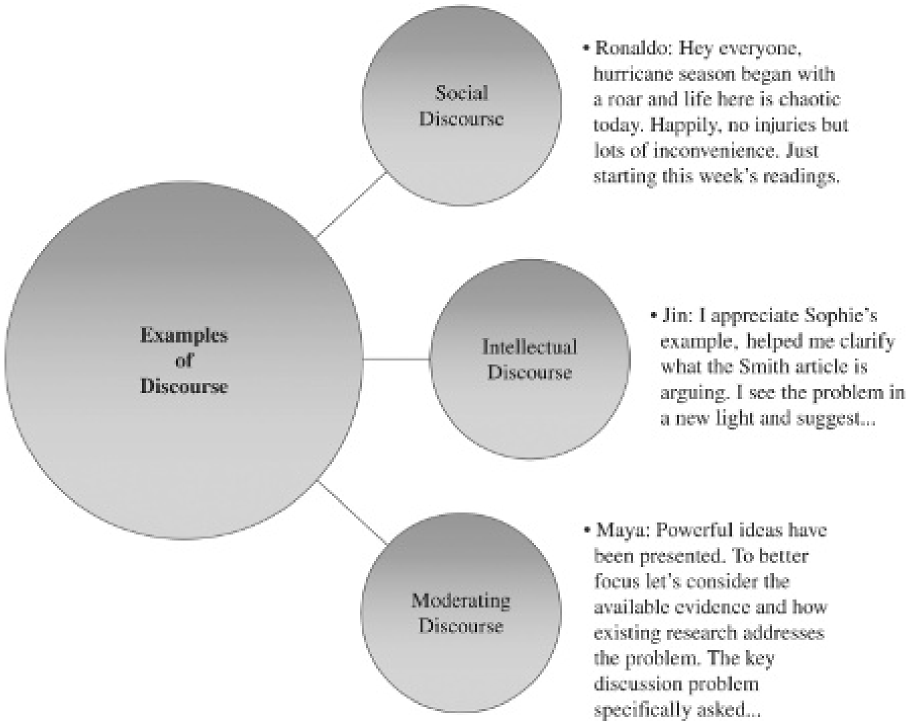


Figure 9.4 Examples of Discourse.

a. Community building:
Social comments, interactions and friendships form the glue for all communities and motivate active and regular member participation. Analysis of the transcripts determined that the volume of social exchange was approximately 25% of the total discourse in the GEN seminars. Social comments were typically part of a message, usually a prelude to a more substantive contribution. Messages that were entirely social, without any reference to the topic, were rare in the seminars.

Social and humorous discourse was a mechanism for participants to connect with one another, even if they had never met previously. Social comments appeared to spice up the discussion, reducing anxiety or pressure related to an exchange, inviting responses and contributing to a sense of commonality.

Trust emerged as an important issue for community building and knowledge building. GEN participants noted the importance of trust in the intellectual exchange. Selected comments are presented below, with minor edits. The names have been omitted or changed to protect privacy. Comments are separated by asterisks (***).

> I was fascinated to watch how this group managed to (a) make me feel welcome in a field I know little about and (b) convey sufficient atmosphere of trust that I could 'fess up to ignorance of things … and seek help.

***

> During a sharing phase, you test the waters … and experience how others in the group present themselves. This builds trust and relief leading to confidence (or not) about offering your own linkages (thinking). Eventually, linkages lead (or not) to building (and agreeing to disagree or

> agree) and/or holding multiple perspectives as a way of appreciating and better understanding the complexity of things—once depth of understanding is collectively sought.
>
> ***
>
> I sense that the measure of every step on this path is related to a collective culture of trust. Growth plays itself out in the later stages via the way that conflict among participants is received and engaged, leading to more or less trust and resulting in continued or less engagement.

Social comments should not be confused with comments that are viewed as without significance to the topic. In the quotation below, the role of the moderator is identified as key to encouraging substantive postings.

> I really like how Lucia honed what I was talking about. Empty praise postings (or any kind of empty reaction posts) don't contribute to the cognitive work being done and can be distracting/time-consuming.

Typically, social comments are most prevalent at the beginning of a seminar, as a form of ice-breaking and self-introduction. And at the end of the seminar, as participants offer concluding remarks, they make reference to colleagues in the discussion, comment on the quality of the seminar and/or moderating and say goodbye to that seminar.

b. Social engagement:
Social engagement refers to the nature and degree to which members demonstrate commitment to the community. Both quantitative and qualitative data are illuminating. Active participation in the form of writing comments and responding to others in the seminar is a key indicator of user engagement. For example, during a 12-month period, 4,000 messages were generated in GEN seminars. During this period, GEN hosted 30 seminars, averaging 100 messages each. Fifteen metaconferences to orient volunteer moderators averaged 38 messages per conference. In addition, a number of SIGs were created but were not studied. Participation levels in GEN were found to be stable year-round. GEN seminars demonstrated a high level of active participation: per week, active participants posted three messages (including replies) and logged in five times.

Another factor that sustained the GEN community was the presence of a committed core of users. Four types of users were identified in the GEN community, according to their level of participation:

- a committed core who participated actively in most of the GEN seminars;
- regular participants who were active in many (about 50%) of the seminars;
- active lurkers who read many of the postings, but who infrequently wrote messages, depending presumably on the subject matter or their availability—GEN had many active lurkers who regularly read the messages and remained current with the communication flows;
- new participants who had yet to demonstrate a particular pattern of behavior.

GEN seminars reflected high levels of user activity. Active participants would read all the messages in a seminar and post replies, comments, disagreements or questions. Level of user engagement is also reflected in the quality of the messages in a seminar, discussed in the section below on Intellectual Discourse.

Other indicators of engagement included voluntary participation in important community-building and knowledge-building activities. Examples include: greeting new participants and introducing them to the group dynamics and the technology of GEN; helping to solve problems; providing new sources of information; creating knowledge artifacts such as seminar summaries, tip sheets, FAQs and manuals. For example, one participant introduced the concept and technology of the "wiki wiki" to GEN in the late 1990s and educated GEN users in its use by using wikis to summarize several GEN seminars. Others provided summaries and syntheses of the seminar using concept mapping tools. As one participant wrote:

> GEN operates on a basis of shared goals and experiences. Facilitators volunteer their time because they are committed to the advancement of both online education and the GEN community itself.

Another noted:

> The GEN community has evolved according to the needs of its members … New events are scheduled by topic, so there is always something new and fresh to build expectations. The proposed seminar topics emerge through former discussions, or member suggestions and many participants take on new roles as leaders and facilitators.

c. User satisfaction:
An important indicator of the success of any community is the experience of the participants. A significant source of data on the social value of GEN's online seminars was user-satisfaction reports. Data on GEN user satisfaction were gathered through online interviews, group surveys, seminars on this topic, analysis of the transcripts of user comments and, more informally, through unsolicited email. During its 5-year history, GEN sought feedback from users as part of the process of continuous improvement of its technical and social design. A sample of the comments on user satisfaction include:

> GEN provides an environment for exploration and sharing of ideas, where learning is a collective and participatory process. GEN is unlike traditional teacher professional development, which focuses on individual learning. Rather, collaboration and group learning are emphasized.

***

> GEN offers new opportunities for dialogue across disciplines, geographical borders, professions, levels of expertise, and education sectors.

***

> GEN provides a connection to everyday realities, current thinking and practices of education professionals. Participants typically draw upon their own experiences to link with, extend, or debate the seminar focus and presentations.

***

> There is no need to participate according to a strict structure. Reading along is acceptable and members are encouraged to join a discussion at any time that they have time, feel compelled, or feel comfortable. As such, there is an opportunity to become acculturated and ease in gradually if that suits the individual.

INTELLECTUAL DISCOURSE

Transcript analysis of the seminars was used to study the intellectual content and progress based on the collaborativist framework presented in Chapter 7. Approximately 75% of the content of the GEN seminars was related to intellectual discourse (the remainder was discourse related to social and procedural issues). Intellectual discourse was categorized according to three types and phases: Idea Generating (brainstorming), Idea Organizing (replying, referencing one another and clustering ideas) and Intellectual Convergence (reflecting final positions). Each online seminar was 2–3 weeks in length. Transcript analysis of the messages in the seminars determined that discourse related to Idea Generating and Idea Organizing (representing Phases 1 and 2) were most common. Intellectual Convergence (Phase 3) occurred when the moderator (or a participant) encouraged final-position statements or when there was a time-sensitive task to complete (such as co-authoring a report, coming to a decision or a position or preparing a presentation for an event).

Qualitative transcript analysis was conducted by coding each message in a seminar according to percentage of the message content that was social or intellectual and, if intellectual, the degree to which the message reflected: (a) Idea Generating, (b) Idea Organizing or (c) Intellectual Convergence. The level of granularity or specificity of coding was flexible: a message could be coded, for example, as 20% social and 80% intellectual (primarily IG), or coded at a finer level of analysis, as needed. A finer level of analysis may be desirable for moderators to monitor and facilitate progress. Instructors may wish to assess the seminar or the participant's contribution. Researchers may seek to identify change and progress over time, or to link moderator/instructor roles with discussant discourse. The analytical rubric can be customized according to the task and desired granularity.

Description of the collaborativist framework and examples drawn from GEN are provided below.

Phase 1: Idea Generating

The nature and quality of the messages is a key indicator. Phase 1 messages typically introduce new ideas and perspectives, and hence are categorized as exemplifying divergent thinking whereby participants present individual points of view and thereby generate a multiplicity of perspectives. The kinds of discourse typical in this phase include:

- *Introductions/initiations/contextualizations*: A seminar begins with an introduction to the seminar topic by the moderator and sets the tone and norms for the discussion. Participants respond with self-introductions: "My name is … and I work at …" This typically provides a context for presenting their initial response to the discussion topic.
- *Introducing ideas and understandings*: This refers to new ideas, beginnings of threads, new topics.
- *Opinion*: Subjective, personal points of view on a topic.
- *Examples*: Personal examples drawn from work experience are used to illustrate a position, a particular point or an opinion.

Phase 2: Idea Organizing

Phase 2 activities are characterized by messages in which participants begin to link ideas, identifying where ideas may be clustered as related, thereby moving from individual comments to collaboration. Phase 2 discussions reflect progress through such quantitative indicators as:

- increased number of reply messages;
- increased number of references to previous messages;
- increased number of references to other participants by name.

Qualitative changes in the nature of the discourse include:

- *Agreement/disagreement statements*: These statements reference a previous message and may present an alternative point of view or request clarification; for example: "Michelle, your comment really got me thinking about this issue because I don't see it the same way. Can you say more about your concerns?"
- *Enhanced individual understanding*: This again is a response to previous messages, exemplified by comments such as "now I understand." Such a comment may indicate incorporating a new perspective into one's thinking, elaborating an existing idea with an example or lead to further questioning.
- *Shared understandings*: Enhanced individual understanding connects with the collective understanding of terms and/or frameworks.
- *Weaving key ideas*: Weaving together ideas, and rising above or building on them, is an important marker of collaboration:

A seminar really benefits when participants cite on another to weave multiple ideas that become platforms for new perspectives.

Phase 3: Intellectual Convergence
Phase 3 messages reflect an increased level of density, for example:

- increased number of substantive contributions, such as messages that compare, rate, structure, rank or synthesize the ideas discussed;
- increased use of adverbial conjunctions such as "and" or "but";
- increased number of conclusive or position statements.

Phase 3 generally consists of convergence and summaries or landscapes.

- *Convergence*. Typically, convergence is most evident when participants are engaged in co-production, whether it be producing a report, a presentation, a point of view, a work of art or a scientific theory. Few GEN seminars focused on production, but there were cases where the seminar involved organizing a panel presentation. An example of such discourse is:

    > Thanks Mary for keeping us focused. I like the ideas that the seminar has proposed and think that you have done a good job in selecting the top five issues. Debating these five, citing examples from our own experiences with online learning, is a great format.

- *Summaries/landscape*. What follows is an excerpt from an online exchange on the topic of creating summaries, landscapes and sidelines in online seminars and discussions:

> Subject: Convergence and summaries
>
> Anyway, we've been talking about effective strategies for summarizing—who should summarize, when, and should there be a term other than "summary." One suggestion is to have a "sideline" type of ongoing summary. (I feel like I'm not explaining this very well!—need pictures!) Have you used similar tools/strategies in your work?

Subject: landscapes instead of summaries

Hi Terry,
We've found the term "landscapes" more useful for this kind of work because the term is not so value-laden or argument-based as a "summary" which is a lens particular to the author (traditionally the group leader, instructor or chief administrator in a business meeting "summarizes" what's been established to this point—from their view).

In describing a landscape, there is more of a sense of the whole in a descriptive sort of way which lessens the pressure for others (readers, in our case) to release other pieces they might have thought worthy until a "summary" was made. Specifically, an author can describe a piece of the landscape, thus leaving it open to bring up and further unpack/explore/re-visit other pieces because they haven't been "discounted" (it's a tone thing more than anything else) in the same way as a summary tends to shed whatever is left out.

It also doesn't require any new "design" features (like a sideline suggests to me, are you thinking of a sort of extra left-hand column?), just training in listening-oriented collaboration.

Subject: re: landscapes instead of summaries

Dear Sara: Landscape. I like it! It sent sparks across my synapses. It provides opportunities to explore the landscape, returning to the same place at different times with new ideas and perspectives.

And you read my mind well, Sara! I was thinking about a sideline tool—something to facilitate the process of pulling out (more like linking to) bits and pieces. But that may be complicating a process that can be achieved nicely within the discussion space itself. Just traversing the landscape of this discussion I continue to pick up new gems I hadn't noticed before, or understand [*sic*] earlier.

MODERATOR DISCOURSE

GEN seminars were launched with a brief presentation by the moderator that posed a topic (problem or discussion question), followed by group discussion that involved debate, multiple perspectives, learning new ideas and coming to some level of convergence, even if it was preliminary. Various approaches to moderating GEN seminars were employed. However, moderator discourse was typically organized around three segments:

1. *Introduction—presentation of topic (or problem posing)*: Each seminar began with a presentation by the moderator; it typically started with greetings and an introduction to the topic and a key question/problem for discussion. Whereas the student-led online seminars described in Chapter 7 posed three discussion questions drawn from the literature, the GEN seminars focused principally on practice-based issues and problems, such as questions related to new pedagogies, technologies or research findings that could advance the field. An overview of the problem helped to anchor the discussion. Seminars generated examples of practice from participants, readings or websites offering specific information, case studies, exemplars, tools or particular research findings that addressed the problem and contributed to knowledge in the field.
2. *Monitoring/facilitating the discussion*: This refers to moderator activities to motivate active participation and to keep the discussion focused and progressing. Regular (daily) moderator presence enables the moderator to check and maintain the flow of the discussion.

Moderators can encourage input by requesting comments from participants or directing queries. Phase 1 activities encourage democratic participation and a range of perspectives. Moderators may also encourage feedback whereby participants seek clarification: "What do you mean by that?" "Can you pls. explain that term?" "What are some examples of that approach?" The moderator or the participants may request evidence to create a tone of informed opinion and discourse. "Why do you state a, b and c?" "What is the evidence for that claim?" "Do you know of any research on that position?" These kinds of evidence questions lead to Phase 2, Idea Organizing. Participants begin to reference one another's ideas, and to find linkages. "How does Joe's comment relate to Ira's point?" "Let me elaborate a bit on Ellen's example. I had a similar problem." Some ideas are challenged and dropped, others strengthened. Linking or referencing comments organizes the perspectives into common themes or clusters. As much as possible, it is important that the expectation is created that everyone is learning together to avoid a Q&A (question and answer) session with the moderator. (This is key—feeling the need to respond to each participant plus answer *all* the questions takes too much time and is not effective moderating.)

3. *Conclusion*: Drawing conclusions and arriving at a position on the topic is an important part of the seminar, reflecting and articulating the knowledge generated through the discourse interaction. This is Phase 3, Intellectual Convergence. Some seminar moderators asked discussants to identify the two most important ideas that each gained, or to vote on a list of five outcomes or to rank the outputs. Wikis and concept maps were generated. Other seminars co-produced position papers or documents. GEN members noted: "Ideally we like to generate some sort of resource for the public archives as a seminar outcome—for example seminar highlights, annotated resource list, or summary of issues."

Transcript analysis of an online seminar can be valuable for studying the intellectual content and progress of the discussion. It is also valuable to help understand, design and implement online seminars: the framework offers a guide for moderators to facilitate and advance the discussion.

Threading analysis is also useful for the moderator to view and intervene in shaping the conversation flow, to decide which areas of the topic need (or not) further discussion and, together with qualitative transcript analysis, what type of discussion is required. The moderator could thus assess how the discussion was flowing, both in terms of covering the topic, as well as advancing from divergent Idea Generating to Intellectual Convergence and decide on appropriate intervention.

TECHNOLOGICAL INDICATORS

The quality and ease-of-use of an online community forum is essential to facilitating member participation. A web-based forum should be easy to install, maintain, administer and use. Open-source online forums are emerging and have the advantage that many developers can contribute to building more advanced features. At the same time, there is a challenge to creating open-source educational environments, since the design is not only computational but pedagogical: it requires expertise in how people communicate, collaborate and build knowledge if features to support these key functions are to be developed. This is still a problem in that people with programming talents typically do not have expertise in learning theory and practice, and vice versa: few educators have the technical expertise to build state-of-the-art learning environments. The lack of a theoretical framework to guide software development can lead to many tools that are developed ad hoc and do not form a coherent whole.

At the same time, new technological developments are emerging to assist collaborative learning and knowledge-building processes, such as tools for scaffolds, annotations and multimedia communication (synchronous and asynchronous), and tools to enable online surveys, voting, ranking, rating and usage analyses. A whole new area of qualitative research analysis is emerging with promising research and development in data visualization, semantic analysis and transcript analysis. These can be the basis for discourse analysis and discourse scaffolding features in online education and OCoP applications. The GEN platform, Virtual-U, was an early example of development in this direction. New initiatives are needed to build software tools and cohesive environments that are based on theoretical frameworks such as collaborativism.

GEN CONCLUSIONS AND INITIATIONS: LESSONS LEARNED

GEN lasted for approximately 5 years and came to an end when the research projects concluded. Nonetheless, the OCoP continued in different online venues and forms. For example, the Virtual-U software was adopted by the UN's International Labour Organization (ILO) and informed the conceptual framework for the AKCIO open-source software developed by the ILO. The lessons from GEN have influenced not only technical but also educational design for formal (university) and non-formal (training) courses and projects. The transcript-analysis approaches have been refined and used in many online course applications.

Wikipedia

Wikipedia, the largest encyclopedia in history, is a work-in-progress constructed by a huge online CoP and operates as a free, collaborative and open process whereby anyone with internet access can contribute and/or make changes to the entries. Since its creation in January 2001, Wikipedia has become a premier online reference destination, with approximately 374 million unique visitors per month as of September, 2015. According to the website, in 2015 there were more than 70,000 active contributors working on more than 41 million articles in over 294 languages. By 2015, there were over 5.3 million articles in English and there were over 30 million registered users, including 1263 administrators. "Every day, hundreds of thousands of visitors from around the world collectively make tens of thousands of edits and create thousands of new articles to augment the knowledge held by the Wikipedia encyclopedia" (http://en.wikipedia.org/wiki/Wikipedia:About).

Because of its quality and uniqueness, the process of collaboratively building such a knowledge artifact is important. Wikipedia states that:

> People of all ages and cultural and social backgrounds can write Wikipedia articles. Most of the articles can be edited by anyone with access to the Internet, simply by clicking the *edit this page* link. Anyone is welcome to add information, cross-references, or citations, as long as they do so within Wikipedia's editing policies and to an appropriate standard. Substandard or disputed information is subject to removal. Users need not worry about accidentally damaging Wikipedia when adding or improving information, as other editors are always around to advise or correct obvious errors, and Wikipedia's software is carefully designed to allow easy reversal of editorial mistakes. (http://en.wikipedia.org/wiki/Wikipedia:About)

Openness and inclusivity is thus the first feature of the Wikipedia process. The openness, inclusivity, size and scope of Wikipedia require editorial administration, oversight and management. This is a second key feature of the Wikipedia process: editorial administration processes developed to ensure quality, validity, reliability and civility to an appropriate standard. Editorial administration is provided through several mechanisms. Approximately 75,000 editors (volunteers who range from expert scholars to casual readers) regularly edit the articles. Methods such as peer review, article assessment and a featured article process intend to provide a rigorous review of articles in order to meet the highest standards and showcase Wikipedia's capability to produce high quality work. Editors also provide stylistic consistency by applying the Wikipedia *Manual of Style*. The construction of the manual is another artifact of Wikipedia's collaborative knowledge building.

The administrators working on the English Wikipedia are an important mechanism for maintaining high standards of quality and civil discourse.

> Editors are able to watch pages and techies can write editing programs to keep track of or rectify bad edits. Over 1,500 administrators with special powers ensure that behavior conforms to Wikipedia guidelines and policies. Where there are disagreements on how to present facts, editors work together to arrive at an article that fairly represents current expert opinion on the subject. The administrators can temporarily or permanently ban editors of Wikipedia who fail to work with others in a civil manner. (https://en.wikipedia.org/wiki/Wikipedia:About)

A central quality of Wikipedia is that, where the quality of an article or contribution improves over time, the process is based on a conversation. Over time, and with much discussion and editing, the Wikipedia article (and the encyclopedia itself) matures and progresses.

> As a wiki, articles are never complete. They are continually edited and improved over time. In general, this results in an upward trend of quality and a growing consensus over a fair and balanced representation of information.
>
> Users should be aware that not all articles are of encyclopedic quality from the start: they may contain false or debatable information. Indeed, many articles start their lives as partisan; and, after a long process of discussion, debate, and argument, they gradually take on a neutral point of view reached through consensus. Others may, for a while, become caught up in a heavily unbalanced viewpoint which can take some time—months perhaps—to achieve better balanced coverage of their subject. In part, this is because editors often contribute content in which they have a particular interest and do not attempt to make each article that they edit comprehensive. However, eventually, additional editors expand and contribute to articles and strive to achieve balance and comprehensive coverage. In addition, Wikipedia operates a number of internal resolution processes that can assist when editors disagree on content and approach. Usually, the editors eventually reach a consensus on ways to improve the article. (https://en.wikipedia.org/wiki/Wikipedia:About)

By 2017, there were over 883 million recorded edits to the English Wikipedia.

The high level of traffic to Wikipedia generally results in responses, disagreements or reports of errors (although this is not foolproof). Nonetheless, as a work-in-progress and with the input of a diverse, global readership, Wikipedia has the advantages of a short editorial cycle. Unlike a paper encyclopedia, which stays the same until the next edition, editors can update Wikipedia at any time to help ensure that articles stay abreast of the most recent events and scholarship. Wikipedia also has the advantage of multiple perspectives and input, unlike a traditional hard-copy encyclopedia that is the product of a select small group of authors and editors who may represent particular slants or perspectives. There are, nonetheless, strengths and weaknesses to the wiki process.

> Wikipedia is written by open and transparent consensus—an approach that has its pros and cons. Censorship or imposing "official" points of view is extremely difficult to achieve and usually fails after a time. Eventually for most articles, all notable views become fairly described and a neutral point of view reached. In reality, the process of reaching consensus may be long and drawn-out, with articles fluid or changeable for a long time while they find their "neutral approach" that all sides can agree on. Reaching neutrality is occasionally made harder by extreme-viewpoint contributors. Wikipedia operates a full editorial dispute resolution process, one that allows time for discussion and resolution in depth, but one that also permits disagreements to last for months before poor-quality or biased edits are removed. (https://en.wikipedia.org/wiki/Wikipedia:About).

Many other mechanisms for addressing issues of quality exist. For example, technologies to support the open, collaborative and asynchronous nature of the discourse have been constructed and refined. The technologies are open source.

> The MediaWiki software that runs Wikipedia retains a history of all edits and changes, thus information added to Wikipedia never "vanishes" irreversibly. Discussion pages are an important resource on contentious topics. Therefore, serious researchers can often find a wide range of vigorously or thoughtfully advocated viewpoints not present in the consensus article. As with any source, information should be checked. A 2005 editorial by a BBC technology writer comments that these debates are probably symptomatic of cultural changes that are happening across all sources of information (including search engines and the media), and may lead to "a better sense of how to evaluate information sources." (https://en.wikipedia.org/wiki/Wikipedia:About)

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Toward an Analytical Framework for OCoPs

Understanding how online communities function and can contribute to learning and to building knowledge is a critical area requiring further discussion and research. The availability of system-generated usage statistics and archived transcripts of the discourse offer powerful quantitative and qualitative data for empirical analyses of OCoPs. Such analyses could proceed along many different paths, for such purposes as monitoring, assessment or research. Some suggestions for descriptive analytics are provided below.

Contextual Indicators

Contextual indicators refer to data that help us to understand the setting and the pulse of an OCoP. Both qualitative and quantitative data are valuable for this purpose—whether for perusing OCoPs to determine which ones suit our interest or for more in-depth investigation. Our first connection to any OCoP will be its name, in other words, qualitative data. When we first encounter an OCoP, we are most likely to survey the topics being discussed in order to gain a sense of the nature of the community and its scope. The topics and message subject headers offer an overview of the considerations of the OCoP. Additional data may be obtained through documentation related to the site as well as examining the transcripts for information such as: (a) when the online community was created; (b) its intent or purpose; (c) how it is organized to meet that purpose; (d) the nature of membership; and (e) affiliations with other organizations, such as a professional association or a journal.

We are then likely to scan the size and currency of the community, by looking, for example, at the number of topics being discussed, the size of membership, the level of messaging and the message dates: this information is provided by numbers or quantitative data. For example: What is the level of activity—is the community alive? How do we know? What signs of life are evident? Are messages being posted? How recently? How actively? Are members posting hourly, daily or infrequently? How many topics or forums exist and are active (or inactive)?

Using a sample of the most recent postings, we can determine whether these were sent by many different participants or the same few. Is there an active core group of members?

We can determine level of activity through system-generated usage statistics that are typically available online and/or by "eyeball analysis," simply scrolling through the transcripts to see and count the number of messages, the size of messages, the date messages were posted and the sender.

What is the size of this community—what is the number of members? How many members are currently active? How long has the community been in existence? Does membership seem to be growing, maintaining or declining?

Change over time is perhaps the critical benchmark of an OCoP, illuminating community building and knowledge building through both quantitative and qualitative data. These are discussed in the next section on social and intellectual indicators. A subsequent section, technological indicators, explores some of the online tools that can currently be used to analyze quantitative and qualitative data, as well as the promising new advances in areas such as visualization and semantic analysis.

Social and Intellectual Indicators of Success

Study of an OCoP at the contextual level is useful for a general overview or scan of the community. However, to understand the value of an OCoP, it is essential to study community building and knowledge building at a deeper level. Social and cognitive indicators are data that can demonstrate how well the online community is developing/advancing socially and intellectually. Powerful opportunities for discourse analysis are possible online, given the system-generated (and archived) transcripts and usage data. Here we discuss three types of discourse:

- social discourse;
- intellectual discourse;
- moderating/facilitating discourse.

SOCIAL DISCOURSE

A key indicator of the success of an online community is active and sustained engagement by the members. The formation of an online community in which members identify themselves as belonging to the group, participate (read and write messages) actively and regularly, and contribute to the sustenance, stability and growth of the community signals an important level of success. Social engagement also reflects intellectual value in an OCoP, since members are motivated to contribute.

Community development and success can be determined by both quantitative and qualitative data. One source of data has already been mentioned in the discussion of contextual indicators: usage statistics can tell us whether the community is alive and well. Levels and volumes of messaging and replies over units of time (hour, day) provide such evidence. Quantitative indicators or measures include system-generated usage statistics such as number of conferences created in a given period of time (a week, month or year); number of messages written per conference in total and per participant; number of messages read per participant; volume of messaging; and pattern of messaging (by time of day, by date, by thread or topic) to view ebbs and flows.

Another source of data is user reports. Quantitative data can be compiled through user surveys or polls to determine subjective reports of satisfaction level. Qualitative analysis of the discourse transcripts can identify user comments expressing, or not expressing, satisfaction. Moreover, the level of social commentary does contribute to and reflect the existence of a community. Social discourse creates social glue: to encourage members to develop friendships and thereby motivate them to participate regularly.

Social discourse occurs in most formal and informal educational settings and can contribute a tone that invites participation. The volume of social comment ranges around 25% of the total exchange, enough to be welcoming but not disrupt the discussions.

Qualitative indicators refer to the nature and quality of the discourse. As noted in Chapter 7, the archivable text-based nature of the discourse enables retrospective analysis. The transcript provides a verbatim copy of the discourse that can then be subject to discourse analysis. Quantitative data and qualitative data are available from the transcripts. Quantitative data are often most easily obtained and analyzed as system-generated usage statistics, which are available on most forum software.

Qualitative data are easily available as the transcripts of the discourse, although few analytical tools and analytical frameworks exist as yet to study online discourse.

INTELLECTUAL DISCOURSE: COLLABORATIVE LEARNING AND KNOWLEDGE BUILDING

Social relationships form an important component in the "glue" of a community. Nonetheless, for OCoPs, the purpose and the draw is the nature and the quality of the intellectual discourse. The quality of the discourse is what distinguishes an OCoP, and is what draws, motivates and sustains active engagement and membership.

Both quantity and quality of messages in an online community offer important indicators of knowledge building and each should be studied and used to deepen understanding of the nature of engagement and degree of success. Success here is understood as the continuity of activity, nature of activity and user satisfaction. The quantity of messaging should not be taken as a sole indication of success, but nor should it be ignored. Levels of participation (such as number of messages per day, per person, per topic, size of a message and other quantitative measures) are an obvious and important indicator of the pulse of an online community. It is important in assessing the distribution of communication and the level of democratic participation and verbalization in a group.

Qualitative transcript analysis based on the collaborativist framework offers indicators or a rubric to understand, monitor, facilitate and assess online collaborative learning and knowledge-building discourse. The GEN case example discussed above demonstrated the application of this framework in studying the social, cognitive and moderating discourse of that OCoP. Messages in a seminar or discussion can be analyzed as comprising one of three categories or phases of conceptual change: Idea Generating, Idea Organizing, Intellectual Convergence. Discourse analysis may identify the predominant type in each message, or assess the level that each type is present in a message.

MODERATING/FACILITATING DISCOURSE

Moderating or facilitating an online discussion benefits from a theoretical framework to guide the process, advance the discourse and to encourage progress toward Intellectual Convergence. Many manuals and books on facilitating techniques have been published or posted online, but without a theoretical base to determine what constitutes progress and how to facilitate Intellectual Convergence. The collaborativist framework is a contribution to this important area.

Moderating also benefits from content knowledge, as well as technical skills and experience with group dynamics and problem-solving. Conceptual knowledge of the discipline or topic as well as pedagogical knowledge related to collaborative learning and knowledge building are very valuable, and it is expected that knowledge of the latter will grow and improve with experience.

Procedural Indicators

Processes and policies to enable and ensure high quality and fluid progress are essential for any community engaged in knowledge building. The Wikipedia example discussed above demonstrated the importance accorded to procedure, in order to develop a process and product of the highest standards. Procedures are continuously being assessed and new processes developed by Wikipedia. To enable open, inclusive and yet high standards, Wikipedia has implemented a very powerful administrative framework with such components as:

- 70,000 contributors provide content;
- a *Manual* for stylistic consistency;
- 1,263 administrators to ensure guidelines and policies are followed;
- open-source tools and software to maintain a historical archive of everything, to facilitate editing and feedback and other processes;
- a policy of continuous improvement of policy and technology;
- articles that are consensus based for the general public and discussion pages for more in-depth exploration of a topic;
- an editorial dispute resolution process.

Technological Indicators

The quality and ease of use of an online learning environment is fundamental to its effective use. It should be easy to access, navigate and interpret. The quality of the technology from the user's point of view should be interesting, satisfying and motivating. However, it should also have embedded support for effective collaborative learning and knowledge-building processes. Some of these supports may be scaffolds that fade away as the user gains proficiency. Others may be tools or templates that are always available. Tools that have shown promise within online learning environments for OCoPs and for online courses include: customizable scaffolds for various types of discourse; system-generated usage data; annotation tools; multimedia tools; and usage analysis tools, transcript analysis tools, visualization software and online evaluation tools to support voting, surveys, ranking and rating. Technological designs and environment are of tremendous interest and importance for advancing online education to support collaborative learning and knowledge building.

OCoP Framework for Analysis

Contextual Indicators (quantitative data)

- Level of participation (per person/per day/per topic)
  - active messaging (# of msgs posted pp/pd)
  - active reading (# of msgs read pp/pd)
- Volume of messaging (stabilizing, growing, declining)
- Stability (levels of participation changed over time)
- Existence of active core group
- Longevity (how long has it been around?)
- Change over time in each of the above indicators.

Social and Intellectual Indicators (qualitative data)

- Social discourse
  - community building
  - user engagement
  - user satisfaction
- Intellectual discourse
  - Idea Generating
  - Idea Organizing
  - Intellectual Convergence
- Moderator discourse
  - introductions/context setting/design/agenda
  - monitoring and advancing
  - conclusions/meta analysis.

Procedural Indicators (qualitative data)

- Administrative discourse, establishing
  - goals and objectives (definition of the OCoP)
  - policy guidelines
  - statement of netiquette
  - what is expected of members, role of members
- Coordinating functions
- Policy/procedures implementation.

Technological Indicators

- Ease of use, access
- Availability of features to support collaborative learning and knowledge building, such as:
  - scaffolds for various discourse types
  - visualization tools (qualitative and quantitative)
  - transcript analysis tools
  - usage analysis tools
  - content-generating tools
  - organization and annotation tools
- Quality of system features
- Technical help/assistance.

Summary

Chapter 9 focused on collaborativism in the context of informal learning, exemplified by online communities of practice (OCoPs). OCoPs function like a knowledge community by building knowledge related to practice. This process was described in some detail in the initial part of the chapter, which focused on the context of OCoPs. The chapter discussed CoPs and proceeded to provide definitions of key and related terms such as community, community of practice, community of interest, community of learning, work group, social network and online community.

This provided a context for examining specific OCoPs related to the field of educational practice. Chapter 9 did not include examples of online communities that were related to formal or non-formal educational settings since these had been covered in Chapters 7 and 8. Two OCoPs examples were presented and described in some detail: the Global Educators' Network (GEN) and Wikipedia. A final section of the chapter considered key indicators of success for an OCoP, such as contextual indicators, social and intellectual indicators, procedural indicators and technological indicators. These indicators, it was suggested, could contribute to a framework for OCoP analyses.

10
Conclusions
In Retrospect and In Prospect

In Retrospect

In October 1969, the first online message was sent. The message was sent from the University of California, Los Angeles to the Stanford Research Institute, some hundreds of miles away. The content of the message, a test, was intended to be "LOGIN," but after the first two letters were transmitted the system crashed. Hence the first online message ever sent was "LO." It was sent by an undergraduate student, Charley Kline.

The internet revolution represents a tiny sliver of time in the history of humanity, and yet the impact has been profound. The growth of the internet has been world changing. But the beginnings were small and seemingly inconsequential. The vast majority of scientists, academics and educators initially had no interest in computer communication, and the rest of society and business had even less. By 1981, only 213 mainframe computers were on the network. However, by 1995, 16 million people were online. Email was beginning to change the world. As discussed in Chapters 2 and 7, educators and professors were among the early adopters. They had begun to use Arpanet (the precursor to the internet) in the mid-1970s. The 1980s was a time of educational exploration of this new medium, although the going was tough: the logistics were terrible as network connectivity with schools and homes was sparse. (Schools in the 1980s and even 1990s did not have modem connections and the only phone in the school was usually in the office of the principal, who had no interest in classroom use of his/her phone even if it was a hookup to the sole computer in the school, which was also typically in his/her office.) Despite the logistical challenges, however, online education took hold even as the field of online technology was taking its baby steps.

The World Wide Web was made public in 1993. In January 1994, there were only an estimated 623 websites online, in total. Then, Amazon was launched online in 1995, Google was launched in

1998, Wikipedia in 2001 and Facebook in 2003. In 2001, there were 513 million people online; by 2010, there were 2 billion.

The internet has become a condition of daily life in today's world. It is an integral part of our work, as well as social and personal communication. Yet, this is not true for the world of education. The internet remains largely extraneous to the "real" work of teaching and learning in the class, where it is treated as an add-on. Surprisingly, despite the early sparks of interest and innovation by educators, the internet revolution has not significantly impacted how we teach.

This chasm has left education seriously isolated from the lives of its students, teachers and the rest of the world. Nonetheless change is imminent. Today everyone in school, college, university and the workplace in most parts of the world has an email account (at least one) and a cell phone, and likely a blog, a website and membership in a social network. Fundamentally, the infrastructure is in place and the users are fluent in its use. It is time for an educational paradigmatic shift to transform learning from didactic instruction to the collaborative knowledge-building discourse that reflects and coheres with the 21st-century Knowledge Age.

When early users were first introduced to email and the internet, the common response was: "What now?" (What do I do with this technology? And why do I need it?). This is similar to the introduction of the telephone in the early 20th century; users were initially suspicious and resistant, and the term "phoney" reflected this negative view of telephone communication. The education system is beginning to overcome its suspicion of online communication and collaboration, but has yet to figure out: What now?

The field of formal education or schooling has historically been uncomfortable with technology although, as this book has argued, learning and technology are integral to human development. Nonetheless, technologies associated with behaviorist, cognitivist and even constructivist learning theories did not have a significant impact on or adoption by the education system. In fact, the inventors of early educational technologies had little contact with teachers and learners, and vice versa. However, as computing and online technologies have mainstreamed, online education has gained ground. Nonetheless, the field remains at an early stage of development, requiring a theory to guide and advance the practice and to ignite the discourse of our knowledge communities toward bolder visions and strategies.

Learning Theories and Online Technologies addresses this need. It examines how learning and technology integrate to advance human development. In particular, *Learning Theory and Online Technologies* has focused on learning theories in the 20th century and introduced collaborativism or online collaborative learning (OCL) as a theory of learning for the 21st century.

As discussed in Chapters 1 and 2, learning has historically shaped and been shaped by technology. Forty thousand years ago, the invention of speech enabled our prehistoric cave-dwelling ancestors to better communicate and learn from one another. Agrarian societies, emerging approximately 10,000 years ago, accumulated production and developed human settlements, and thereby came to require the ability to account for stored goods for purposes of ownership, trade and taxation. Writing was invented to enable the recording of information and its reproduction, transmission and archiving. Literacy, the ability to read and write, required people with the skills to keep records and accounts. Formal instructor-led education was invented to ensure that appropriate literacy skills were taught, learned and assessed.

Until the late 19th century, however, the vast majority of society learned through non-formal education (such as mentorship) and informal (experiential, observational, trial-and-error) approaches to learning. Formal education and schooling, based on literacy, was restricted to a small elite.

The extension of formal education and literacy to the mass population came about only around the 19th century, thousands of years after literacy was invented. The machine age both enabled and required a literate society. The relatively recent invention of the printing press had made reading materials far more available. The rise of the manufacturing era needed literate workers who could read and follow simple instructions to run the machines; this led to mass schooling and the efficient didactic model of learning. The term "didactic" means "intended to teach or to instruct." The term originated in the mid-17th century from the Greek *didaktikos* and *didaskein* ("teach"). The didactic approach focuses on instruction and is teacher centered.

The rise of manufacturing coincided with the historical period of the scientific revolution. With the rise of modern science came the development of human sciences such as psychology and, by extension, a focus on learning and education. Theories were developed that could be tested by positivist (empirical) methods and which could inform human and natural sciences.

Chapter 1 introduced theory as a point of view or premise whereby we observe and make "sense" of the observations. Learning theory provides educational researchers and practitioners with a framework for viewing the field and for connecting how we understand learning not only with our practice, but with research and knowledge within our own and other disciplines.

A theory of learning is based on empirical evidence. A theory asks questions about "why" or "how" and seeks to answer these questions through evidence-based study and by drawing on empirical data and verifiable facts. Until the emergence of positivism in the 19th century, natural philosophy (science) in the Western world was largely based on metaphysical belief or religious beliefs on the divine origin of thought. Positivism challenged and changed the emphasis from metaphysics to modern science based on empirical evidence. This led to theories of human science, such as learning theory, as well as the theories of natural sciences. Learning theories do continue to have a relationship with philosophy (such as epistemology and ideology) but are grounded in observable and demonstrable conditions, related to physical evidence rather than metaphysical or spiritual explanations.

With the rise of positivism, the emphasis on empirical data and evidence gained authority over belief-generated ideas, contributing to scientific method. Scientific method, prevalent throughout the natural sciences, required "proof" rather than conjecture or "belief." Learning theories were first developed in the 20th century, and the term theory was initially fundamentally linked to positivist science. This has changed in recent decades, as new models of learning are based less on clinical experimentation and are more field oriented. Chapters 3–5 discuss 20th-century theories of learning, to help us understand the broader field and to reflect on our own ideas and practice.

The earliest theories of learning, behaviorism and cognitivism (discussed in Chapters 3 and 4), were strongly informed by the positivist ethos. Experimental controlled studies in the lab were echoed in instructional theories that were didactic and highly controlled in practice, with the instructor assuming a prescriptive role. The focus was to create explicit conditions for learning that would yield the intended results, in an empirically observable manner. The role of the instructor (or instructional designer) is emphasized over the role of the learner. Instructional design prescribed specific steps to achieve particular results, whether these steps be articulated by the instructor/trainer or embedded in software to run instructional technologies such as a teaching machine, computer-assisted instruction or intelligent tutoring systems. Effective learning was understood as accurate reproduction and repetition of existing knowledge.

Constructivist learning theory, discussed in Chapter 5, emerged to some degree as a counter position to the objectivist epistemology and instructor-centered approaches that characterize behaviorist and cognitivist learning theory. Constructivism, particularly social constructivism, posited a view of knowledge as constructed through peer discussion and interaction with the environment. Didactic instruction associated with behaviorist and cognitivist theories was critiqued and rejected by constructivist pedagogies in favor of student-centered learning.

Constructivist learning pedagogies emphasized active learning and learning-by-doing and these characterized education in the 1980s and 1990s.

Chapter 6 presented the proposed theory of connectivism based on the idea that a networked environment without instructors and course structure will facilitate and achieve learning among participants. Chapter 7 then focused on collaborative knowledge-construction discourse mediated by online technologies as a new paradigm for learning to address the challenges and needs of the 21st-century Knowledge Age. The focus of collaborativism (aka online collaborative learning theory or OCL) is on collaborative discourse and knowledge-building processes associated with knowledge communities. Collaborativism provides a theoretical framework based on three phases of collaborative discourse that progress from divergent thinking to Intellectual Convergence. These phases characterize conceptual change and knowledge building. They also inform collaborativist pedagogical and technological design and assessment.

Chapters 8 and 9 provide practical cases to demonstrate how collaborative learning works in the real world, with scenarios and case examples drawn from all sectors of formal, non-formal and informal educational applications. Online education is being successfully adopted and implemented by institutions and organizations worldwide, and the lessons inform the development of collaborative learning theory and educational practice.

Learning Theory and Online Technologies provides an overview of learning theories in the 20th century and introduces collaborativism as a 21st-century theory of learning to guide educational practitioners and researchers in realizing the full potential of online technologies for the Knowledge Age. The book provides a retrospective analysis of learning theory but given its vantage point on the cusp of a paradigmatic shift, it has also looked ahead at imminent prospects.

In Prospect

The term *prospect* is rich in meaning: it can be a vision, a promise, a likelihood or an undertaking. As a verb, it denotes exploration. Collaborativism represents and can realize all of these possibilities. Online education, for example, is being designed in myriad ways to revolutionize and improve how we understand and practice learning and knowledge creation. We are on the verge of a breakthrough, beginning to see new educational horizons unlike any known to date. Without becoming futuristic, some potential scenarios that are already or almost available are presented below.

1. Online Communities of Practice: as professional development, lifelong learning and curricula OCoP become a major force in education

One of the major events of the next few decades will almost certainly be an unprecedented investment in professional development and lifelong learning for educators. The dearth of options to date will be addressed in response to the pent-up demand and need. One of the major and most interesting options will arguably be the heightened role of OCoPs for educators. These are already emerging and were, in fact, among the earliest applications of the internet in the 1970s and 1980s. OCoPs will grow and improve to become a major force in Knowledge Age education.

Peer interaction and engagement with experts, scholars and scientists in related fields open unprecedented opportunities for educators to learn, to progress and improve, through participation in the relevant knowledge communities. OCoPs will improve the abilities of educators and expand their opportunities to shape the future. OCoPs can help teachers to improve their disciplinary knowledge skills. For example, participation by science teachers (at all levels) in online communities of knowledge enables school teachers to engage in scientific discourse and research and thereby learn the concepts, appreciate the scope and nature of the issues and understand the methodologies whereby these issues are addressed empirically. OCoPs could similarly benefit teachers and scholars in other fields. OCoPs already reflect a variety of knowledge practices, from the more pragmatic to the highly conceptual, and educators in the discipline can both contribute to and learn from participation.

School curricula might similarly be transformed by engaging students as well in online knowledge community discussions, at various levels of theory and practice. Many opportunities can be envisioned as students and teachers engage in OCoPs, with peers, scholars, scientists and practitioners in the discipline. Online discourse communities might be one way to transform classroom, curriculum and pedagogy to advance beyond "teaching to the test."

2. Open Source, Open Knowledge have a tremendous impact on how we think about design, process and product, and who can engage in these activities

The rise of the open-source movement in software and subsequently in educational resources and curriculum has introduced a radical departure from commercial off-the-shelf, prepackaged content to free, user-created designs, content and products. Open Knowledge is a term used to denote a set of principles and methodologies related to the production and distribution of knowledge goods in an *open* manner. Knowledge is interpreted broadly to include data (for example, scientific, historical), content (such as music, books, video) and general information. As set out in the Open Knowledge Definition, knowledge is open if "one is free to use, reuse, and redistribute it without legal, social or technological restriction" (see www.opendefinition.org).

Open knowledge and open content have led to the creation of large non-commercial repositories of data, information and content such as educational course manuals, lesson plans, etc. The availability of open-content repositories and directories, such as the OpenCourseWare Consortium (a portal linking to free and openly licensed course materials from universities worldwide), the Massachusetts Institute of Technology (MIT) OpenCourseWare site with materials from 2,000 MIT courses or repositories of curricula that cover almost all disciplines and levels from schooling to training, is truly remarkable. The challenge is how to use and benefit from these curricula. The options range from outright adoption of these course curricula to modifying or adapting the content or using the material as a benchmark or even inspiration for new pedagogies or ways of teaching particular concepts.

Without theoretical or pedagogical frameworks, however, there is a high risk of teachers importing or reproducing the content and employing didactic teaching approaches at the expense of encouraging learners to construct knowledge and create their own content. The intent of open content may be excellent, but the implementation requires careful consideration.

3. State-of-the-Art Technological Advances: Semantic webs, visualization and other analytic tools will transform and enhance learning, teaching and the study of learning

The Semantic Web vision was conceived by Tim Berners-Lee, the inventor of the World Wide Web. Calling it the next step in web evolution, Berners-Lee describes the Semantic Web as a web of data that can be processed directly and indirectly by computers.

The internet as we know it is an amazing repository of documents, with almost boundless amounts of information. However, while our web browsers can easily access this information, it must be read and analyzed by humans in order to extrapolate any useful conclusions or insights.

The developers of the Semantic Web propose to have data as well as documents on the Web so that computers can process, transform, organize and even act upon the data in useful ways. In the Semantic Web data itself will become part of the Web and will be able to be processed independently of application, platform or domain.

New developments and experimentation with new qualitative and quantitative analytical tools such as latent semantic analysis, text mining and data mining promise powerful and much needed advances for the study and practice of learning. Visualization tools to graphically represent data can help us to understand social and cognitive processes in online education. Such tools are beginning to emerge. Visualization software that is simple to use and which can reflect change over time (such as line charts) is of particular value to educational transcript analysis and visualization—for educators, learners and researchers.

4. Increased Magnitude of Computing Power and Storage

New computing tools are emerging at a tremendous rate to create qualitatively new dimensions of discourse, collaboration and knowledge construction. Cloud computing, for example, is dramatically expanding computing power and capabilities. Cloud applications such as powerful repositories of information are being linked with problem-solving analytical tools to enrich online collaboration and knowledge building. Nanotechnology, the science of building machines at the subatomic level and scale, suggests profound implications for educational software and hardware, radically revolutionizing social, physical and intellectual architecture.

The scale of change in computer processing and storage will be increasingly astounding, as evidenced below.

Bit: A Bit is the smallest unit of data that a computer uses. It can be used to represent one of two states of information, such as "Yes" or "No." This was the earliest computing power, akin to Turing's computer.

Byte: A Byte is equal to 8 Bits. 1 Byte could be equal to one character; 10 Bytes could be equal to a word.

Kilobyte: A Kilobyte is approximately 1,000 Bytes (actually 1,024). 1 Kilobyte would be equal to this paragraph, whereas 100 Kilobytes would equal an entire page. The Commodore 64 and Apple IIe computers of the early 1980s had 64 Kilobytes of memory.

Megabyte: A Megabyte is approximately 1,000 Kilobytes. 100 Megabytes will hold two volumes of an encyclopedia.

Gigabyte: A Gigabyte is approximately 1,000 Megabytes. 100 Gigabytes could hold the entire library floor of academic journals.

Terabyte: A Terabyte is approximately 1 trillion Bytes, or 1,000 Gigabytes. A Terabyte could hold 1,000 copies of the *Encyclopaedia Britannica*. 10 Terabytes could hold the printed collection of the Library of Congress. Cell phones and personal computers are rapidly approaching this capacity.

Petabyte: A Petabyte is approximately 1,000 Terabytes or 1 million Gigabytes. 1 Petabyte could hold 500 billion pages of standard printed text.

Exabyte: An Exabyte is approximately 1,000 Petabytes or 1 billion Gigabytes.

Zettabyte: A Zettabyte is approximately 1,000 Exabytes.

Yottabyte: A Yottabyte is approximately 1,000 Zettabytes. It would take a few trillion years to download a yottabyte file from the internet using high-power broadband.

We can see the story of human communication in reverse, in terms of today's technological storage capacity of human communication:

1 Yottabyte = the internet;
5 Exabytes = speech: all the words ever spoken by humankind;
5 Petabytes = printed text: most of the words ever printed by humankind.

The Internet Revolution introduced us to unprecedented access to other people. We now interact with friends, family, peers, colleagues, experts and relevant others on a local and global basis. We are a species distinguished by intentional collaboration and communication. Our survival and development is based on our ability to collaboratively learn and innovate. Online communication has exponentially expanded as well as transformed our opportunities to learn and create knowledge together. Schools, laboratories, libraries and knowledge communities of the 21st century will be networks. Online networks, by facilitating collaboration and discourse, have become crucibles for knowledge and innovation. Teachers and learners today have the fortunate opportunity to contribute to and participate in shaping this new online environment, and thereby, most importantly, fully engage in their mission of advancing the conversation of humankind.

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