CHAPTER 2

TOWARD A THEORY OF ONLINE LEARNING

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It is the theory which decides what we can observe.
~ Albert Einstein (1879-1955)

There is nothing more practical than a good theory.
~ Leonid Ilyich Brezhnev (1906-1982)

Introduction

Theory has both been celebrated and condemned in educational practice and research. Many proponents have argued that theory allows—even forces—us to see the "big picture" and makes it possible for us to view our practice and our research from a broader perspective than that envisioned from the murky trenches of our practice. This broader perspective helps us to make connections with the work of others, facilitates coherent frameworks and deeper understanding of our actions, and perhaps most importantly allows us to transfer the experience gained in one context to new experiences and contexts. Critics of theory (Wilson, 1999) have argued that too strict an adherence to any particular theoretical viewpoint often filters our perceptions and blinds us to important lessons of reality. The intent of this chapter is to look at learning theory generally, and then focus on those attributes of the online learning context that allow us to develop deeper and more useful theories of online learning

Wilson (1997) has described three functions of a good educational theory. First, it helps us to envision new worlds. Few of us need help envisioning new worlds in the midst of the hype and exuberance of online learning proponents that flood the popular press, but we do need theory to help us envision how education can

best take advantage of the enhanced communication, information retrieval, and management capability provided by the Net. It is all too easy to consider new innovations in a "horseless carriage" manner, and to attempt to develop new actions based on old adaptations to obsolete contexts.

Second, a good theory helps us to make things. We need theories of online learning that help us to invest our time and limited resources most effectively. There are many opportunities, but always a critical shortage of resources, a situation which demands that we maximize the efficiency of our development and delivery efforts. This book contains a number of chapters with particular recommendations and suggestions for online course development and teaching. It is hoped that this chapter provides a theoretical "big picture" that will help make sense of these specific recommendations.

Third, Wilson argues that a good theory keeps us honest. Good theory builds upon what is already known, and helps us to interpret and plan for the unknown. It also forces us to look beyond day-to-day contingencies and to ensure that our knowledge and practice of online learning is robust, considered, and ever expanding.

This chapter begins with a general assessment of how people learn that is based on Bransford, Brown, and Cocking's (1999) work. It then assesses the unique characteristics of the Web that enable it to enhance these generalized learning contexts; that is, the Web's "affordances." The chapter next discusses the six forms of interaction and their critical role in engaging and supporting both learners and teachers. It then presents a model of e-learning, a first step toward a theory in which the two predominant forms of e-learning—the collaborative and independent study modes—are presented, with a brief discussion of the advantages and disadvantages of each. The chapter ends with a discussion of the emerging tools of the "Semantic Web" and the way they will affect future developments of the theory and practice of online learning

Attributes of Learning

As many theorists have argued (Garrison & Shale, 1990), and as practitioners experience for themselves, online learning is a subset

of learning in general; thus, we can expect issues relevant to how adults learn generally to be relevant to how they learn in an online context. In an insightful book on the "new science of learning," Bransford, Brown, and Cocking (1999) provide evidence that effective learning environments are framed within the convergence of four overlapping lenses. They argue that effective learning is learner centered, knowledge centered, assessment centered, and community centered. Discussing each of these lenses helps us to define learning in a general sense, before we apply this analytical framework to the unique characteristics of online learning.

Learner Centered

A learner-centered context is not one in which the whims and peculiarities of each individual learner are uniquely catered to. In fact, we must be careful to recognize that learner-centered contexts must also meet the needs of the teacher, of the institution, of the larger society that provides support for the student and the institution, and often of a group or class of students. For this reason, I have argued elsewhere (Anderson, in press) that this attribute might more accurately be labeled "learning centered," than "learner centered."

Learner-centered learning, according to Bransford et al., includes awareness of the unique cognitive structures and understandings that the learners bring to the learning context. Thus, a teacher makes efforts to gain an understanding of students' pre-existing knowledge, including any misconceptions that the learner starts with in their construction of new knowledge. Further, the learning environment respects and accommodates the particular cultural attributes, especially the language and particular forms of expression, that the learner uses to interpret and build knowledge. Learner-centered activities make extensive use of diagnostic tools and activities, so that these pre-existing knowledge structures are made visible to both the teacher and the student.

Online learning can present challenges to educators, because the tools and opportunities for discovering students' preconceptions and cultural perspectives are often limited by bandwidth constraints that limit the view of body language and paralinguistic clues. Some researchers have argued that these restrictions

negatively affect the efficacy of communication (Short, Williams, & Christie, 1976). Others have argued that the unique characteristics that define online learning (most commonly asynchronous text-based interaction) can actually lead to enhanced or hyper communications (Walther, 1996).

We have found evidence of significant social presence in computer conferencing contexts (Rourke, Anderson, Archer, & Garrison, 2002; Rourke & Anderson, 2002). Nonetheless, it is fair to say that the challenges of assessing student preconditions and cultural prerequisites are often more difficult in an online learning context, because teachers are less able to interact transparently with students—especially in the critical early stages of the formation of a learning community. It is for this reason that experienced online learning teachers make time at the commencement of their learning interactions to provide incentive and opportunity for students to share their understandings, their culture, and unique aspects of themselves. This sharing can be done formally, through electronically administered surveys and questionnaires, but is often accomplished more effectively by virtual icebreakers, and by the provision of an opportunity for students to introduce themselves and to express any issues or concerns to the teacher and the class.

The online learning environment is also a unique cultural context in itself. Benedikt (1992) has argued that cyberspace "has a geography, a physics, a nature and a rule of human law" (p. 123). Many students will be new to this context, but increasingly, students will come to online learning with preconceptions gathered from both formal and informal experience in virtual environments. They will exercise their mastery of communication norms and tools, some of which will not be appropriate to an educational online context. Researchers have attempted to quantify this proficiency and comfort with online environments through the use of survey instruments that measure a learner's internet efficacy (Eastin & LaRose, 2000). They have argued that it is not Internet skill alone that determines competency; rather, a strong sense of Internet efficacy allows users to adapt effectively to the requirements of working in this environment. Thus, the effective online learning teacher is constantly probing for learner comfort and competence with the intervening technology, and providing safe environments for them to increase their sense of Internet efficacy. Learner-centered online-learning contexts thus are

sensitive to the cultural overlay acquired in offline contexts, and the ways in which it interacts with the Web's affordances.

Knowledge Centered

Effective learning does not happen in a content vacuum. McPeck (1990) and other theorists of critical thinking have argued that teaching generalized thinking skills and techniques is useless outside of a particular knowledge domain in which they can be grounded. Similarly, Bransford et al. argue that effective learning is both defined and bounded by the epistemology, language, and context of disciplinary thought. Each discipline or field of study contains a world view that provides often unique ways of understanding and talking about knowledge. Students need opportunities to experience this discourse, as well as the knowledge structures that undergraduate teaching affords. They also need opportunities to reflect upon their own thinking: automacy is a useful and necessary skill for expert thinking, but without reflective capacity, it greatly limits one's ability to transfer knowledge to an unfamiliar context or to develop new knowledge structures.

In comparison to campus-based learning, online learning neither advantages nor disadvantages knowledge-centered learning. As I discuss below, the Net provides expanded opportunities for students to plunge ever deeper into knowledge resources, thus affording a near limitless means for students to grow their knowledge, to find their own way around the knowledge of the discipline, and to benefit from its expression in thousands of formats and contexts. However, this provision of resources can be overwhelming, and the skillful e-teacher needs to provide the "big picture" scaffolding on which students can grow their own knowledge and discipline-centered discoveries.

Assessment Centered

The third perspective on learning environments presented by Bransford et al. is the necessity for effective learning environments to be assessment centered. In making this assertion, they do not give unqualified support for summative assessments (especially those supposedly used for national or provincial accountability),

but rather look to formative evaluation that serves to motivate, inform, and provide feedback to both learners and teachers.

Quality online learning provides many opportunities for assessment: not only opportunities that involve the teacher, but also ones that exploit the influence and expertise of peers, others that use simple and complex machine algorithms to assess student production, and, perhaps most importantly, those that encourage learners to assess their own learning reflectively. Understanding what is most usefully rather than what is most easily assessed is a challenge for the designers of online learning. Developments in cognitive learning theories and their application to assessment design are helping us to devise assessments that are aligned with the subject content, and that assess cognitive processes as well as end results. For example, Baxter, Elder, and Glaser (1996) found that competent students should be able to provide coherent explanations, generate plans for problem solution, implement solution strategies, and monitor and adjust their activities. I am continually disappointed when reviewing assessments that my own children are subjected to in school and at university to note the very high percentage of recall questions and the lack of assessment strategies that effectively measure the four sets of competencies identified by Baxter et al.

Can we do any better in online learning? The diminution of opportunities for immediate interaction between learners and teachers might reduce opportunities for process assessment; however, the enhanced communications capacity of online learning and the focus of most adult online learning in the real world of work provide opportunities to create assessment activities that are project and workplace based, that are constructed collaboratively, that benefit from peer review, and that are infused with both the opportunity and the requirement for self-assessment.

A danger of assessment-centered learning systems is the potential increase in the workload demanded of busy online learning teachers. Strategies that are designed to provide formative and summative assessment with minimal direct impact on teacher workload are urgently needed. There is a growing list of tools that provide such assessment without increased teacher participation, including

- the use of online computer-marked assessments that extend beyond quizzes to simulation exercises, virtual labs, and other automated assessments of active student learning;

- collaborative learning environments that students create to document and assess their own learning in virtual groups;
- mechanisms, such as online automated tutors, that support and scaffold students' evaluation of their own work and that of their peers;
- student agents who facilitate and monitor peer activities to allow students to assess and aid each other informally;
- the use of sophisticated software tools, such as latent semantic analysis (LSA) or neural networks, to machine-score even complicated materials, such as students' essays.

Thus, the challenge of online learning is to provide high quantity and quality of assessment while maintaining student interest and commitment. These goals are often best achieved through the development of a learning community, to which we turn next.

Community Centered

The community-centered lens allows us to include the critical social component of learning in our online learning designs. Here we find Vygotsky's (1978) popular concepts of social cognition to be relevant as we consider how students can work together in an online learning context to create new knowledge collaboratively. These ideas have been expanded in Lipman's (1991) community of inquiry and Wenger's (2001) ideas of community of practice to show how members of a learning community both support and challenge each other, leading to effective and relevant knowledge construction. Wilson (2001) has described participants in online communities as having a shared sense of belonging, trust, expectation of learning, and commitment to participate and to contribute to the community.

Although there are many online learning researchers who celebrate the capacity to create learning communities at a distance (Harasim, Hiltz, Teles, & Turoff, 1995), there are also those who note problems associated with lack of attention and participation (Mason & Hart, 1997), economic restraints (Annand, 1999), and an in-built resistance among many faculty and institutions to the threatening competition from virtual learning environments (Jaffee, 1998). Ethnographic studies of the Net (Hine, 2000) illustrate how

the lack of "placedness" and the complications of anonymity attenuate different components of community when the community is located in virtual space. In short, it may be more challenging than we think to create and sustain these communities, and the differences—linked to a lack of placedness and synchronicity, that is, mutual presence in time and place—may be more fundamental than the mere absence of body language and social presence.

I have been struck by the wide variation in the expectations of learners about participation in a community of learners. Traditionally, distance education has attracted students who value the freedom from constraints of time and place that is provided by independent modes of distance education. Contrary to popular belief, the major motivation for enrollment in distance education is not physical access, but rather, temporal freedom to move through a course of studies at a pace of the student's choice. Participation in a community of learners almost inevitably places constraints on this independence, even when the pressure of synchronous connection is eliminated by use of asynchronous communications tools. The demands of a learning-centered context might at times force us to modify the prescriptive participation in communities of learning, even though we might have evidence that such participation will further advance knowledge creation and attention. The flexibility of virtual communities allows more universal participation, but a single environment that responds to all students does not exist; thus, the need for variations that accommodate the diverse needs of learners and teachers at different stages of their life cycles.

These potential barriers argue for a theory of online learning that accommodates, but does not prescribe, any particular boundaries of time and place, and that allows for appropriate substitution of independent and community-centered learning. To this requirement, we add the need for a theory of e-learning that is learning centered, provides a wide variety of authentic assessment opportunities, and is grounded in existing knowledge contexts.

Affordances of the Net

Effective educational theory must address the affordances and the limitations of the context for which it is designed (Norman, 1999).

The World Wide Web is a multifaceted technology that provides a large set of communication and information management tools that can be harnessed for effective education provision. It also suffers from a set of constraints that are briefly outlined in this section.

Online learning, as a subset of all distance education, has always been concerned with providing access to educational experience that is at least more flexible in time and in space than campus-based education. Access to the Web is now nearly ubiquitous in developed countries. The *Wall Street Journal* of February 4, 2002, reported that 54% of U.S. adults use the Web on a regular basis, and 90% of 15-17 years olds are regular Web users. This high percentage of users would probably include well over 90% of those citizens interested in taking a formal education course. Access to the Web is primarily through home or workplace machines, but placements in public libraries and Internet cafes and connections through personal wireless devices are such that access poses no problems for the vast majority of citizens of developed countries. I have also been surprised by the availability of access in developing countries, as exemplified by free use of the Net in McDonald's restaurants in Sao Paulo, Brazil, and the numerous Internet cafés, in most Chinese cities. Access is still problematic for those with a variety of physical handicaps; however, in comparison with books or video media, the Web provides much greater quality and quantity of access to nearly all citizens, with or without physical disabilities.

Access is increasing, not only to technology, but also to an ever-growing body of content. The number of scholarly journals (see http://www.e-journals.org), educational objects (see http://www.merlot.org/Home.po), educational discussion lists (see http://www.kovacs.com/directory), courses (see http://courses.telecampus.edu/subjects/index.cfm), and general references to millions of pages of commercial, educational, and cultural content (see http://www.google.com) is large and increasing at an exponential rate. Thus, online learning theory must acknowledge the change from an era of shortage and restrictions in content to one in which content resources are so large that filtering and reducing choice is as important as providing sufficient content.

The Web is quickly changing from a context defined by text-based content and interactions to one in which all forms of media

are supported. Much of the early work on the instructional use of the Internet (Harasim, 1989; Feenberg, 1989) assumed that asynchronous text-based interaction defined the medium. Techniques were developed to maximize interaction using this relatively lean medium. We are now entering an era where streaming video, video and audio conferencing, and virtual worlds are readily available for educational use. Thus, online learning theory needs to help educators to decide which of the many technological options is best suited for their application.

The Web's in-built capacity for hyperlinking has been compared to the way in which human knowledge is stored in mental schema and to the subsequent development of mental structures (Jonassen, 1992). Further, the capacity for students to create their own learning paths through content that is formatted with hypertext links is congruent with constructivist instructional design theory that stresses individual discovery and construction of knowledge (Jonassen, 1991).

Finally, the growing ease with which content can be updated and revised (both manually and through use of autonomous agent technology) is making online learning content much more responsive and potentially more current than content developed for other media. The explosion of Web "blogs" (Notess, 2002) and user-friendly course-content management systems, built into Web delivery systems such as WebCT or Blackboard, is creating an environment in which teachers and learners can very create and update their course content without the aid of programmers or designers. Naturally, this ease of creation and revision leads to potential for error and less-than-professional-standard output; however, educators who are anxious to retain control of their educational content and context welcome this openness and freedom.

Education is not only about access to content, however. The greatest affordance of the Web for educational use is the profound and multifaceted increase in communication and interaction capability that it provides. The next section discusses this affordance in greater detail.

Defining and Valuing Interaction in Online Learning

Communication technologies are used in education to enhance interaction between all participants in the educational transaction. However, although interaction has long been a defining and critical component of the educational process and context, it is surprisingly difficult to find a clear and precise definition of this concept in the education literature. In popular culture, the use of the term to describe everything from toasters to video games to holiday resorts further confuses precise definition. I have discussed the varying definitions of interaction at length in an earlier paper (Anderson, 2003), and so I will here simply accept Wagner's (1994) definition of interaction as "reciprocal events that require at least two objects and two actions. Interactions occur when these objects and events mutually influence one another" (p. 8).

Interaction (or interactivity) serves a variety of functions in the educational transaction. Sims (1999) has listed these functions as allowing for learner control, facilitating program adaptation based on learner input, allowing various forms of participation and communication, and acting as an aid to meaningful learning. In addition, interactivity is fundamental to creation of the learning communities espoused by Lipman (1991), Wenger (2001), and other influential educational theorists who focus on the critical role of community in learning. Finally, the value of another person's perspective, usually gained through interaction, is a key learning component in constructivist learning theories (Jonassen, 1991), and in inducing mindfulness in learners (Langer, 1989)

Interaction has always been valued in distance education, even in its most traditional, independent study format. Holmberg (1989) argued for the superiority of individualized interaction between student and tutor when supported by written postal correspondence or by real-time telephone tutoring. Holmberg also introduced us to the idea of simulated interaction that defines the writing style appropriate for independent study models of distance education, programming that he referred to as "guided didactic interaction." Garrison and Shale (1990) defined all forms of education (including that delivered at a distance) as essentially

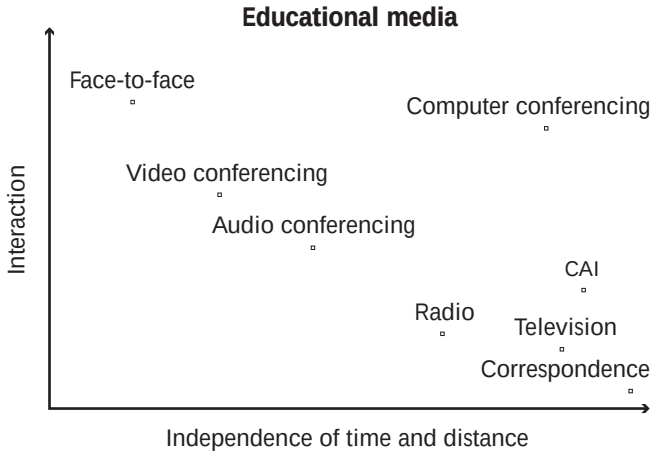


Figure 2-1. Attributes of educational media.

interactions between content, students, and teachers. Laurillard (1997) constructed a conversational model of learning in which interaction between students and teachers plays the critical role.

As long ago as 1916, John Dewey referred to interaction as the defining component of the educational process that occurs when the student transforms the inert information passed to them from another, and constructs it into knowledge with personal application and value (Dewey, 1916). Bates (1991) argued that interactivity should be the primary criterion for selecting media for educational delivery. Thus, there is a long history of study and recognition of the critical role of interaction in supporting, and even defining, education.

The Web affords interaction in many modalities. In Figure 2-1, we see the common forms of media used in distance education charted against their capacity to support independence (of time and place) and their capacity to support interaction. It can be seen that, generally, the higher and richer the form of communication, the more restrictions it places on independence.

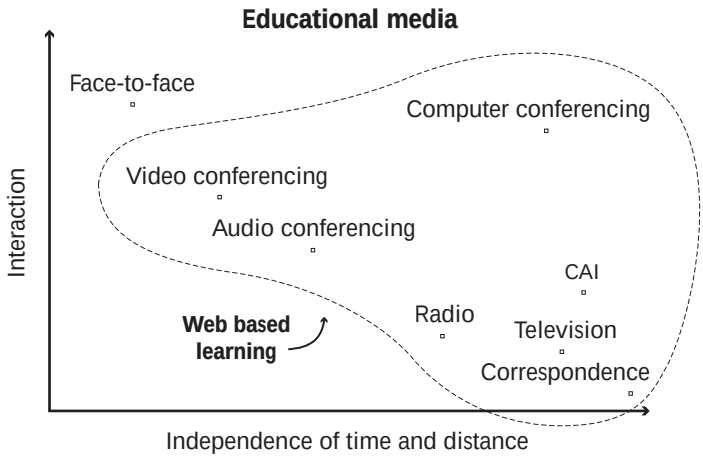
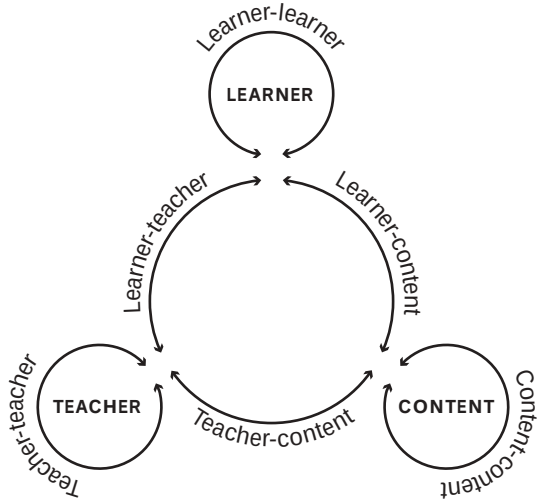


Figure 2-2. Educational media subsumed by the Web.

Figure 2-2 shows the capability of the Web to support these modalities. As can be seen, all forms of mediated educational interaction are now supported, assuming one adds the use of the Web to enhance classroom-based education. Thus, the capacity for the Web to support online learning in general is usually too large a domain for meaningful discussion until one specifies the particular modality of interaction in use.

Interaction can also be delineated in terms of the actors participating in it. Michael Moore first discussed the three most common forms of interaction in distance education: student-student, student-teacher, and student-content (Moore, 1989). This list was expanded by Anderson and Garrison (1998) to include teacher-teacher, teacher-content, and content-content interaction. I have been developing an equivalency theorem describing the capacity to substitute one form of interaction for another, based on cost and accessibility factors (Anderson, 2002; Anderson, 2003). Figure 2-3 illustrates these six types of educational interaction, and each is described briefly below.

Figure 2-3.
Educational interactions.



Student-student Interaction

Traditionally, student-student interaction has been downplayed as a requirement of distance education as a result of constraints on the availability of technology and an earlier bias among distance-education theorists toward individualized learning (Holmberg, 1989). Modern constructivist theorists stress the value of peer-to-peer interaction in investigating and developing multiple perspectives. Work on collaborative learning illustrates potential gains in cognitive learning tasks, as well as increases in completion rates and the acquisition of critical social skills in education (Slavin, 1995). Work by Damon (1984) and others related to peer tutoring illustrates the benefits to both the tutor and the tutee that can result from a variety of forms of "reciprocal" teaching. Finally, peer interaction is critical to the development of communities of learning (Wenger, McDermott, & Snyder, 2002) that allow learners to develop interpersonal skills, and to investigate tacit knowledge shared by community members as well as a formal curriculum of studies.

Student-teacher Interaction

Student-teacher interaction is supported in online learning in a large number of varieties and formats that include asynchronous and synchronous communication using text, audio, and video. The facility of such communications leads many new teachers to be overwhelmed by the quantity of student communications and by the rise in students' expectations for immediate responses.

Student-content Interaction

Student-content interaction has always been a major component of formal education, even in the form of library study or the reading of textbooks in face-to-face instruction. The Web supports these more passive forms of student-content interaction, and also provides a host of new opportunities, including immersion in microenvironments, exercises in virtual labs, online computer-assisted tutorials, and the development of interactive content that responds to student behavior and attributes (often referred to as "student models"). Eklund (1995) lists some potential advantages of such approaches, noting that they allow instructors to

- provide an on line or intelligent help facility, if a user is modeled and their path is traced through the information space;
- use an adaptive interface based on several stereotypical user classes to modify the environment to suit individual users; and
- provide adaptive advice, and model the learner's use of the environment (including navigational use, answers to questions, and help requested) to make intelligent suggestions about a preferred individualized path through the knowledge base.

To these advantages must be added the capacity for immediate feedback, not only for formal learning guidance, but also for just-in-time learning assistance through job aids and other performance support tools.

Teacher-teacher Interaction

Teacher-teacher interaction creates the opportunity for professional development and support that sustains teachers through communities of like-minded colleagues. These interactions also encourage teachers to take advantage of knowledge growth and discovery in their own subject and within the scholarly community of teachers.

Teacher-content Interaction

Teacher-content interaction focuses on the creation of content and learning activities by teachers. It allows teachers continuously to monitor and update the content resources and activities that they create for student learning.

Content-content Interaction

Content-content interaction is a newly developing mode of educational interaction in which content is programmed to interact with other automated information sources, so as to refresh itself constantly, and to acquire new capabilities. For example, a weather tutorial might take its data from current meteorological servers, creating a learning context that is up-to-date and relevant to the learner's context. Content-content interaction is also necessary to provide a means of asserting control of rights and facilitating tracking of the use of content by diverse groups of learners and teachers.

A Model of E-learning

A first step in theory building often consists of the construction of a model in which the major variables are displayed and the relationships among the variables are schematized. Figure 2-4 provides a model that illustrates the two major modes of online learning.

The model illustrates the two major human actors, learners and teachers, and their interactions with each other and with content.

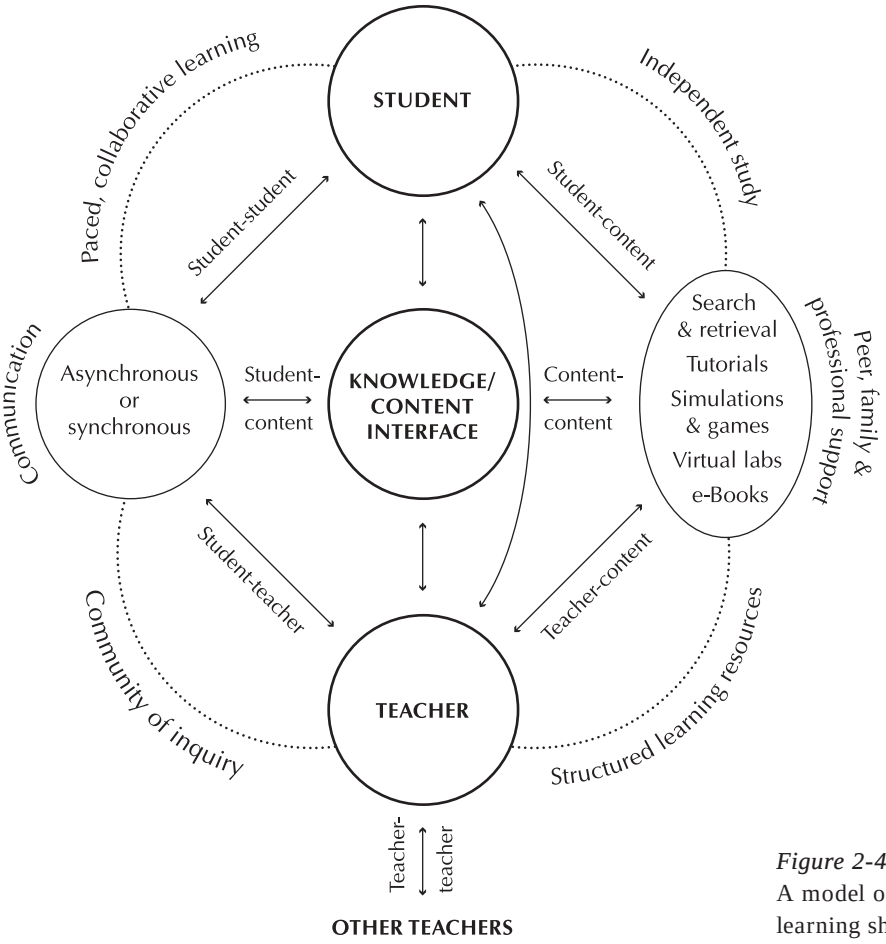


Figure 2-4.
A model of online learning showing types of interaction.

Learners can of course interact directly with content that they find in multiple formats, and especially on the Web; however, many choose to have their learning sequenced, directed, and evaluated with the assistance of a teacher. This interaction can take place within a community of inquiry, using a variety of Net-based synchronous and asynchronous activities (video, audio, computer conferencing, chats, or virtual world interaction). These environments are particularly rich, and allow for the learning of social skills, the collaborative learning of content, and the development of personal relationships among participants. However, the

community binds learners in time, forcing regular sessions or at least group-paced learning. Community models are also, generally, more expensive, as they suffer from an inability to scale to large numbers of learners. The second model of learning (on the right) illustrates the structured learning tools associated with independent learning. Common tools used in this mode include computer-assisted tutorials, drills, and simulations. Virtual labs, in which students complete simulations of lab experiments, and sophisticated search and retrieval tools are also becoming common instruments for individual learning. Printed texts (now often distributed and read online) have long been used to convey teacher interpretations and insights in independent study. However, it should also be emphasized that, although engaged in independent study, the student is not alone. Often colleagues in the work place, peers located locally (or distributed, perhaps across the Net), and family members have been shown to be significant sources of support and assistance to independent study learners (Potter, 1998).

Using the online model, then, requires that teachers and designers make crucial decisions at various points. A key decision factor is based on the nature of the learning that is prescribed. Marc Prensky (2000) argues that different learning outcomes are best learned through particular types of learning activities. Prensky asks not, "How do students learn?" but more specifically, "How do they learn what?"

Prensky (2000, p. 156) postulates that, in general, we all learn:

- behaviors through imitation, feedback, and practice;
- creativity through playing;
- facts through association, drill, memory, and questions;
- judgment through reviewing cases, asking questions, making choices, and receiving feedback and coaching;
- language through imitation, practice, and immersion;
- observation through viewing examples and receiving feedback;
- procedures through imitation and practice;
- processes through system analysis, deconstruction, and practice;

- systems through discovering principles and undertaking graduated tasks;
- reasoning through puzzles, problems, and examples;
- skills (physical or mental) through imitation, feedback, continuous practice, and increasing challenge;
- speeches or performance roles through memorization, practice, and coaching;
- theories through logic, explanation, and questioning.

Prensky also argues that there are forms and styles of games that can be used, online or offline, to facilitate the learning of each of these skills.

I would argue that each of these activities can be accomplished through e-learning, using some combination of online community activities and computer-supported independent-study activities. By tracing the interactions expected and provided for learners through the model, one can plan for and ensure that an appropriate mix of student, teacher, and content interaction is designed for each learning outcome.

Online Learning and the Semantic Web

We are entering an era in which the Web is changing from a medium to display content, to one in which content is endowed with semantic meaning (Berners-Lee, 1999). If the format and structure of content is described in formalized and machine-readable languages, then it can be searched and acted upon, not only by humans but also by computer programs commonly known as autonomous agents. This new capacity has been most prominently championed by the original designer of the Web, Tim Berners-Lee, and is named by him the "Semantic Web."

The Semantic Web will be populated by a variety of autonomous agents—small computer programs designed to navigate the Web, searching for particular information and then acting on that information in support of their assigned task. In education, student agents will be used for intelligent searching of relevant content, and as secretaries for booking and arranging for collaborative meetings, for reminding students of deadlines, and for negotiating with the

agents of other students for assistance, collaboration, or socialization. Teacher agents will be used to provide remedial tuition, and to assist with record keeping, with monitoring student progress, and even with marking and responding to student communications. Content itself can be augmented with agents that control rights to its use, automatically update it, and track the means by which the content is used by students (Thaiupathump, Bourne, & Campbell, 1999; Shaw, Johnson, & Ganeshan, 1999).

The Semantic Web also supports the reuse and adaptation of content by supporting the construction, distribution, and dissemination of digitized content that is formatted and formally described (Wiley, 2000; Downes, 2000). The recent emergence of educational modeling languages (Koper, 2001) allows educators to describe, in a language accessible on the Web, not only the content but also the activities and context or environment of learning experiences. Together these capabilities afforded by the Semantic Web allow us to envision an e-learning environment that is rich with student-student, student-content, and student-teacher interactions that are affordable, reusable, and facilitated by active agents (see Figure 2-5, below).

Toward a Theory of Online Learning

The Web offers a host of very powerful affordances to educators. Existing and older education provisions have been defined by the techniques and tools designed to overcome the limitations and exploit the capacities of earlier media. For example, the earliest universities were constructed around medieval libraries that afforded access to rare hand-written books and manuscripts. Early forms of distance education were constructed using text and the delayed forms of asynchronous communications afforded by mail services. Campus-based education systems are constructed around physical buildings that afford meeting and lecture spaces for teachers and groups of students. The Web provides nearly ubiquitous access to quantities of content that are many orders of magnitude larger than those provided in any other medium.

From our earlier discussion, we see that the Web affords a vast potential for education delivery that generally subsumes almost all the modes and means of education delivery previously used, with

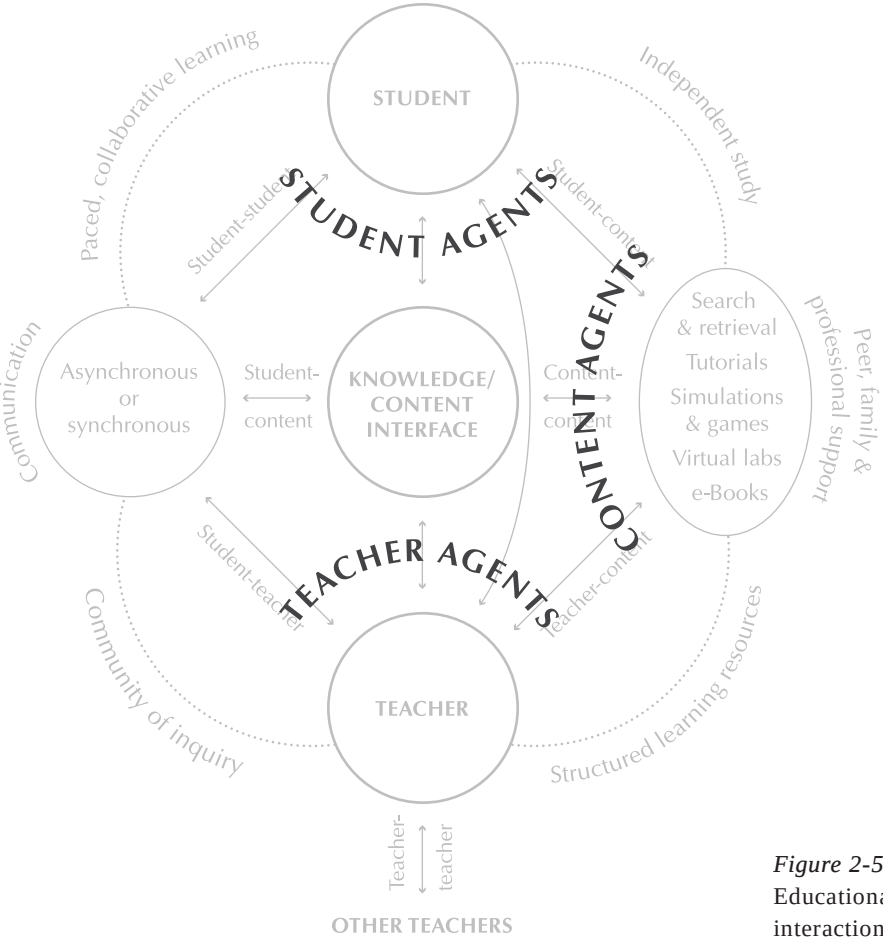


Figure 2-5. Educational interactions on the Semantic Web.

perhaps the exception of the rich face-to-face interaction of the classroom. We have also seen that the most critical component of formal education consists of interaction between and among multiple actors, humans and agents included.

Thus, I conclude this chapter with an overview of a theory of online learning interaction that suggests that the various forms of student interaction can be substituted for each other, depending on costs, content, learning objectives, convenience, technology, and available time. The substitutions do not result in decreases in the quality of the learning that results. More formally:

> Sufficient levels of deep and meaningful learning can be developed, as long as one of the three forms of interaction (student-teacher; student-student; student-content) is at very high levels. The other two may be offered at minimal levels or even eliminated without degrading the educational experience. (Anderson, 2002)

The challenge for teachers and course developers working in an online learning context is to construct a learning environment that is simultaneously learning centered, content centered, community centered, and assessment centered. There is no single, right medium of online learning, nor a formulaic specification that dictates the kind of interaction most conducive to learning in all domains with all learners. Rather, teachers must learn to develop their skills so that they can respond to student and curriculum needs by developing a set of online learning activities that are adaptable to diverse student needs. Table 2-1 illustrates how the affordances of these emerging technologies can be directed so as to create the environment that is most supportive of "how people learn."

Table 2-1. Affordances of the network environment and the attributes of "How people learn."

"How people learn" framework (Bransford et al.)	**Affordances of the current Web**	**Affordances of the Semantic Web**
Learner centered	Capacity to support individualized and community centered learning activities	Content that changes in response to individualized and group learner models
Knowledge centered	Direct access to vast libraries of content and learning activities organized from a variety of discipline perspectives	Agents for selecting, personalizing, and reusing content
Community centered	Asynchronous and synchronous; collaborative and individual interactions in many formats	Agents for translating, reformatting, time shifting, monitoring, and summarizing community interactions
Assessment centered	Multiple time- and place-shifted opportunities for formative and summative assessment by self, peers, and teachers	Agents for assessing, critiquing, and providing "just in time feedback"

Conclusion

This discussion highlights the wide and diverse forms of teaching and learning that can be supported on the Web today, and the realization that the educational Semantic Web will further enhance the possibilities and affordances of the Web, making it premature to define a particular theory of online learning. However, we can expect that online learning, like all forms of quality learning, will be knowledge, community, assessment, and learner centered. Online learning will enhance the critical function of interaction in education in multiple formats and styles among all the participants. These interactions will be supported by autonomous agents working on behalf of all participants. The task of the online course designer and teacher is to choose, adapt, and perfect (through feedback, assessment, and reflection) educational activities that maximize the affordances of the Web. In doing so, they create learning-, knowledge-, assessment-, and community-centered educational experiences that result in high levels of learning by all participants. Integration of the new tools and affordances of the Semantic Web further enhances the quality, accessibility, and affordability of online learning experiences.

Our challenge as theory builders and online practitioners is to delineate which modes, methods, activities, and actors are most effective, in terms of cost and learning, in creating and distributing quality e-learning programs. The creation of a model is often the first step toward the development of a theory. The model presented illustrates most of the key variables that interact to create online educational experiences and contexts. The next step is to theorize and measure the direction and magnitude of the effect of each of these variables on relevant outcome variables, including learning, cost, completion, and satisfaction. The models presented in this chapter and other chapters in this book do not yet constitute a theory of online learning, but it is hoped that they will help us to deepen our understanding of this complex educational context and lead us to hypotheses, predictions, and most importantly improvements in our professional practice. It is hoped that the model and discussion in this and other chapters in this book lead us toward a theory of online learning.

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