Delia Neuman
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Learning in Information-Rich Environments

I-LEARN and the Construction of Knowledge from Information

Second Edition

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For Michael Neuman
For Dan, Danielle, Casey, and Faith DeCarlo
For Dave Kurz and Charis and Phoebe Wu
For Rick Drasch
For Kristin, Hunter, and Sophia Grant

Preface

The information environment has exploded since the first edition of this book appeared in 2011, a little less than a decade ago. Not only have the amount and kinds of information ballooned—all the ways in which information is created, disseminated, manipulated, and interpreted have soared as well. Nevertheless, all of us are still learners—as we were in 2011—and now we must navigate an even more agitated sea of information to make sense of the world. From the time the cell phone alarm beeps or chimes in the morning to the time the last tweet is received for the night, we are flooded with information

- that asks us to pay attention (or gives us a way to vegetate),
- that invites us to distinguish the useful from the useless (or allows us to lose ourselves in the fog), or
- that calls on us to create new products of our own (or encourages us to be passive consumers of others' ideas).

The information comes in all formats—print, visuals, music, talk, exhibits, digital files, and even odors. It comes through avenues as traditional as the daily newspaper and television news and as modern as the latest blog or social media site. The one characteristic that all the formats and avenues have in common is that they all convey varieties of *information*. Together, they offer a tsunami of facts, ideas, and opinions that we can access, evaluate, and use to build an understanding of the world and of ourselves—that is, to learn.

The amount and range of information available to us today is unprecedented. Phrases like "the information revolution," "the information (or knowledge) society," "the knowledge economy," and similar expressions underscore the truism that our society has been transformed by virtually instantaneous access to virtually unlimited stores of information. Thomas Friedman was among the first to tell us that the world is flat (2005/2007) and that we must devise new political and economic understandings based on the ceaseless communication of information from all corners of the world. Governments continue to tell us that information relating to national security is so time-sensitive that we must allow new kinds of surveillance to keep society safe. Teenage subscribers to social networks not only access

information but enter text and video images and publish them widely—becoming the first adolescents in history to be creators as well as consumers of vast quantities of information.

If the characteristics of "the information age" demand new conceptions of commerce, national security, and publishing—among other things—it is logical to assume that they carry implications for education as well. In fact, a good deal has been written about how education as a whole must transform its structure and curriculum to accommodate the possibilities offered by new technologies. Far less has been written, however, about the *specific* implications of these technologies—and the information they allow students (and all learners) to access and create—for the central purpose of education: learning. What does "learning" mean in an information-rich environment? What are its characteristics? What kinds of tasks should it involve? What concepts, strategies, attitudes, and skills must educators and students master to learn effectively and efficiently in such an environment? How can researchers, theorists, and practitioners foster the well-founded and widespread development of such key elements of the learning process?

This book explores these questions and suggests some tentative answers. All its original chapters have been revised—some quite extensively—and several new chapters have been added to provide fresh insights. Chapter 1 still begins by portraying information not just as a collection of facts, ideas, and opinions but as a tool for learning that provides the basic building blocks for critical thinking and problem solving. Chapters 2 and 3 expand on their predecessors in the first edition to define and describe the formal and informal information-rich environments that surround us and to show how their evolution suggests a need for an expanded conception of learning itself. Chapter 4 and new Chap. 5 paint an updated picture of learners as "information users" and describe their needs and abilities for learning in information-rich environments—particularly as elements of digital and critical literacies have come to enrich the notion of "information literacy." Chapter 6 (formerly Chap. 5) draws on the core ideas found in the earlier chapters to provide a framework for learning in the kinds of dynamic, information-rich environments available today and to offer Neuman's (2011a, b) I-LEARN model as a way to guide information-based learning at the highest levels. Chapter 7 (formerly Chap. 6) closes the book's theoretical focus on learning in information-rich environments by discussing contemporary assessment approaches and describing how the model can serve as a tool for evaluating learning in both formal and informal settings. New Chap. 8 draws on all five authors' research over the past several years to validate the I-LEARN model in a variety of schools and at all levels of the educational system. This final chapter completes the circle from theory to design to practice by illustrating how using the model can help learners master the process of learning with information.

Today, information in all its vastness and variety provides the raw material for the kind of learning that all of us must master as we encounter new realities in society and in our personal lives. Indeed, the process of accessing, evaluating, using, and creating information constitutes the "authentic learning" that contemporary education promotes and that all of us must pursue throughout our lives. By exploring some of the key ideas and issues related to learning with information at this

point in the information age, this book attempts to provide some insights and suggestions that will help educators and those we serve make steady progress in that pursuit.

The authors are indebted to many people for insights and encouragement that played an essential role in creating this book. Delia Neuman is still deeply grateful to all those cited in the original edition—especially to her husband Michael for his continuing encouragement and support and to Kara Howland, whose illustrations continue to grace this edition—and to the four coauthors whose hard work and solid insights have given this revised edition a broader perspective, a deeper research base, and far richer practical guidance than its predecessor was able to offer. Mary Jean Tecce DeCarlo would like to thank her patient family and the wonderful real-world teachers and students who inspired Chap. 8. Vera Lee would like to thank her husband and children for their flexibility and understanding about late nights and work weekends. Stacey Greenwell would like to thank her partner and best friend, Rick Drasch, for all his support during this project, and Dr. Gary J. Anglin, her dissertation advisor, for introducing her to Delia. Allen Grant would like to thank the early adopters of I-LEARN for their enthusiasm and willingness to share their ideas, materials, and students in order to advance the fields of information, digital, and critical literacy. All the authors are utterly in debt to graduate assistant Aly Meloche, whose substantive knowledge, technical skills, and quiet patience have been invaluable. Finally, Delia Neuman published the first edition of the book in 2011. Without her vision, this updated book—and the I-LEARN-related research, presentations, and publications noted here—would not have been possible. Her coauthors would like to thank her for her invaluable mentorship and her scholarly generosity.

Any errors in the book belong, of course, to the authors; any value it offers is attributable to many others as well.

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Reference

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Chapter 1
Information as a Tool for Learning

Abstract Especially today—when information bombards us and when concerns about "disinformation," "alternative facts," and "truth decay" permeate personal and professional conversations—educators must develop a deep understanding of information itself and of the central role it plays in life and in learning. This chapter sets the stage for the rest of the book by providing an overview of theories from information studies and instructional design and development that suggest the nature and importance of information in all areas of learning. Reviewing definitions of information from both fields, the chapter shows how the views converge to present information as a network of entities and relationships that is dynamic, complex, multifaceted, and multipurpose. At its core, information consists of facts, concepts, procedures, and metacognitive strategies—the very things that constitute what we learn. Through learning, information is transferred from the environment into human cognitive systems to become the components of our internal knowledge. Drawing on contemporary understandings of learning as an active, self-directed, internal process by which humans make sense of the information we encounter, the chapter explores the parallels between today's definitions of information and of learning to argue that information itself is the basic building block for authentic learning in the information age and that accessing, evaluating, and using information skillfully are at the heart of learning itself.

Over a 100 years ago, the philosopher William James described the infant's view of the world as a "big, blooming, buzzing confusion" that enveloped his or her mind (1890, p. 488). If he were writing today, James might conclude that *information* is the "buzzing confusion" that seems to suffuse our every waking moment. In fact, many authors have provided colorful interpretations of "information": we have all heard that "information is power," and McCandless (2012) told us that "information is beautiful" (http://www.informationisbeautiful.net). President Ronald Reagan once referred to information as "the oxygen of the modern age" that "seeps through the walls topped by barbed wire [and] wafts across the electrified borders" (*London Guardian* 1989, June 14). T.S. Eliot, musing in 1934 on behalf of many humanists facing the modern age, offered perhaps the most famous questions of all about the nature and role of

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information: "Where is the wisdom we have lost in knowledge? Where is the knowledge we have lost in information?" (1962, p. 96).

Every scholarly and professional field defines "information" in ways that connote its own particular needs and foci. For medicine, information includes vital signs, data on drug interactions, and test results; for journalism, it consists (at least in part) of leads, leaks, tweets, and recovered emails. For information professionals—librarians, information scientists, information managers, and others who work with various kinds of information in a range of contexts—and for educators—teachers, curriculum developers, instructional designers, librarians, media specialists, administrators, and others who work with information in various learning environments—information also has specialized connotations.

This book takes the position that information is not only powerful and beautiful but that it is the basic building block for human learning. Drawing primarily on research and practice in the fields of information studies and instructional design and development, the book suggests a way to think about constructing knowledge that is directly applicable in today's information age. It offers ideas that will be of interest to researchers and theorists from its two core disciplines and related fields and also to those who teach the research process—postsecondary faculty, librarians, and information specialists as well as K-12 teachers, school librarians, and media specialists. In sum, this book is intended for anyone who believes—or who at least wants to consider—the proposition that "developing expertise in accessing, evaluating, and using information is in fact the authentic learning that modern education seeks to promote" (American Association of School Librarians and Association for Educational Communications and Technology, 1998, p. 2).

Looking at information as it is understood by information professionals and by those who design and deliver instruction leads to a powerful insight: in today's world, information is, at bottom, the basis for learning. Understanding the nature and role of information in learning is crucial to understanding how learning itself has changed in the information age. Recognizing the profundity of this change is, in turn, critical to fostering deep and meaningful learning in today's information-rich environments. The perspectives reviewed and offered here provide key information—yes, information—about this phenomenon.

1.1 What Is Information? The View from Information Studies

Traditionally, information theorists have looked at information—and particularly "recorded information"—as their particular focus along a four-stage continuum: data, information, knowledge, and wisdom. In this view, "data" are discrete bits of content that exist independently of one another. "Information" (especially recorded information) implies not only content but also some level of organization of that content that integrates its various components. "Knowledge" adds value—and the human dimension—to the continuum by implying cognitive processes that expand basic organizational patterns into more complex understandings that bring various sets of information together. "Wisdom" is the ultimate value-added stage of the continuum, suggesting human understanding and use of organized knowledge with judgment and insight.

Today's information professionals are the beneficiaries of Buckland's (1991) more nuanced definition of information, one that blurs the distinction between information and knowledge and posits that information is more dynamic than such a clear dichotomy suggests. According to Buckland, information can be conceptualized as a process (i.e., the communication act); as knowledge (i.e., an increase of understanding or a reduction in uncertainty); and as a thing (i.e., an object that imparts information). Marchionini (1995) builds on Buckland's ideas to note that information "is anything that can change a person's knowledge" and that it "includes objects in the world, what is transferred from people or objects to a person's cognitive system, and … the components of internal knowledge in people's minds" (p. 5).

Other "theorists of information" offer variations on these definitions that flesh out specific components according to the particular focus of the definer. Scholars concerned with creating information systems, for example, assume that information is something that must be organized according to specific approaches in order to allow efficient access and retrieval—the traditional concern of librarians and other information practitioners (see, for example, Soergel, 1985; Taylor, 1999). Researchers who have studied information users' interactions with such systems have developed process-oriented models of information seeking that assume information is part of a dynamic whole that changes and develops as the information-seeking process progresses (see, for example, Dervin, 1983, 1992, 1998; Dervin, Foreman-Wernet, & Lauterbach, 2003; Dervin & Nilan, 1986; Johnson, 2003; Kuhlthau, 1985, 1988, 1993, 1997; Pettigrew, Fidel, & Bruce, 2001; Spink, 1996; Vakkari & Hakala, 2000). Other writers have their own variations on these themes, and the precise definition of "information" continues to be a topic of debate within the field.

Overall, however, all the definitions of information within the information field suggest that information is neither a monolithic concept (e.g., the undifferentiated product of "the media") nor a collection of unrelated pieces (e.g., facts, numbers, and images). Rather, it is a series of discrete yet interrelated elements that appear along a continuum ranging from the purely physical to the fully abstract. Both the elements and the interrelationships are constituents of the larger construct of "information." Content and process as well as external and internal are linked in a complex and dynamic whole. Even though traditional organizational systems and patterns are challenged by the ways information is linked and organized through contemporary technologies—through personal and social tagging online, for example—the assumption that information must be organized to be useful still holds (see Park & Howarth, 2013).

Thinking of information as a complex and multifaceted concept allows us to see it as represented by "entities" and "relationships" that we can mix and match according to their nature and the uses to which we would like to put them. For example, we can conceive of a blog as information in each of Marchionini's (1995) three senses: it is an *object in the world*; its content is a particular representation of ideas that is *transferred* to its readers; and the readers' *internalization* of those representations is the "stuff" of their knowledge. An information user might focus on the technological format of the object, the nature and quality of the content to be transferred, or the mechanisms by which one processes and organizes the content to increase understanding or reduce uncertainty. All these foci are information, and all are related to one another in both obvious and subtle ways.

1.2 What Is Information? The View from Instructional Design and Development

Within the overarching field of education, the subfield of instructional design and development is the source of most of the theory underlying the conceptualization and creation of learning activities. Also known as "instructional systems design," "instructional technology," and "educational technology," this area has been a formal discipline for over 60 years and has been defined as "an organized procedure that includes the steps of analyzing, designing, developing, implementing, and evaluating instruction" (Seels & Richey, 1994, p. 31). As the definition suggests, the central "information" concern of instructional designers involves selecting, organizing, and presenting information in ways that enhance the possibility of learning.

Instructional designers—the usual title for practitioners in the field—are more concerned with the pedagogical uses of information than with organizing information for access and retrieval. But writings from this field echo information specialists' understanding of information as a set of entities that are discrete and have specific characteristics and relationships. Early—and key—theorists like Gagne (1985) and Merrill (1983, 1999) proposed "categories of learning" and "components of learning" that correspond closely to different types of information and of information use, from making simple stimulus-response connections to engaging in complex problem solving. While the details of their work—and the work of many others over the years—need not concern us here, some illustration of the "pieces" of information these two theorists posited provides a useful context.

After a lifetime of work on classifying kinds of learning and looking for ways to achieve each kind, Gagne (1985) ultimately proposed five types of "learned capabilities"—verbal information, intellectual skills, motor skills, attitudes, and cognitive strategies—and specified four kinds of "intellectual skills"—discriminations, concepts, rules, and problem solving. Focusing on those categories most closely allied with the cognitive dimension implied by the definitions of "information" above, we can see that Gagne's hierarchy assumes a number of more or less clearly defined subcategories, or types, of information:

- Verbal information might be called information at face value, since it consists of symbols such as words or musical notations without reference to their underlying meanings.
- Cognitive strategies are techniques and skills—all of which involve knowledge of types of information—that individuals use to manage their learning.
- Discriminations involve differences among objects varying in such basic properties as color, shape, and size.
- Concepts can be concrete (e.g., table) or defined (e.g., democracy) and are in essence ideas about things that are joined by particular relationships into basic categories.

- Rules are statements that relate classes of stimuli to classes of responses (e.g., two pints make a quart) that enable us to respond predictably to situations even when we are unable to state an appropriate rule. Gagne considered rules the "stuff of thinking" (Gagne, 1985, p. 157).
- Problem solving—the category in which a specific kind of information merges inseparably with information use—involves "discover[ing] a combination of previously learned rules which can be applied to achieve a solution for a novel situation" (Gagne, 1985, p. 155). The elements of discovery, combination, and novelty move this kind of thinking with rules to a higher kind of knowledge.

Merrill's (1983) "component display theory" provides another example of the notion that information consists of discrete but interrelated entities that have particular uses. Merrill proposed that information to be learned consists of four types—facts, concepts, principles, and procedures. He further posited that learning involves three different kinds of performance—remember, use, and find. According to Ragan and Smith (2004), Merrill formed the rationale for his categorization on "some assumptions about the nature of subject matter" (Merrill, 1983, p. 298, quoted in Ragan and Smith, p. 632)—suggesting, once again, that theorists of instructional design and development view information as consisting of interrelated entities. Merrill expanded the number and breadth of those entities in his later work by identifying 13 types of learning in his "instructional transaction theory" (Merrill, 1999; Merrill, Jones, & Li, 1992). This refinement of his thinking reaffirms his early work and its proposition that information consists of multifaceted and interrelated components.

1.2.1 The Knowledge Dimension

These early ideas are revisited and reflected in a key contemporary view of information from the perspective of instructional development and design: "the knowledge dimension" outlined in Anderson and Krathwohl's (2001) *A Taxonomy for Learning, Teaching, and Assessing*. This dimension posits that knowledge—or, in other words, information, as defined above—can be characterized as falling into four categories: factual knowledge, conceptual knowledge, procedural knowledge, and metacognitive knowledge. What is significant about this formulation for a discussion of information and learning is that it appears in what is considered the current version of "Bloom's *Taxonomy*," one of the most important and widely used sets of ideas in instructional design and indeed in American education for over 50 years. Bloom's original *Taxonomy of Educational Objectives*, published in 1956, delineated six "levels of learning" but did not directly specify the types of information involved in these levels. The inclusion of a "knowledge dimension" in this first-ever revision and update of Bloom's *Taxonomy* indicates the importance to contemporary instructional design and development of understanding the components of information that underlie learning across the spectrum of levels of complexity.

As shown in Fig. 1.1, Anderson and Krathwohl (2001) define four "types of knowledge": factual knowledge, conceptual knowledge, procedural knowledge, and metacognitive knowledge.

MAJOR TYPES AND SUBTYPES	EXAMPLES
A. FACTUAL KNOWLEDGE –	The basic elements students must know to be acquainted with a discipline or solve problems in it
Aa. Knowledge of terminology	Technical vocabulary, musical symbols
Ab. Knowledge of specific details and elements	Major natural resources, reliable sources of information
B. CONCEPTUAL KNOWLEDGE –	The interrelationships among the basic elements within a larger structure that enable them to function together
Ba. Knowledge of classifications and categories	Periods of geological time, forms of business ownership
Bb. Knowledge of principles and generalizations	Pythagorean theorem, law of supply and demand
Bc. Knowledge of theories, models, and structures	Theory of evolution, structure of Congress
C. PROCEDURAL KNOWLEDGE -	How to do something, methods of inquiry, and criteria for using skills, algorithms, techniques, and methods
Ca. Knowledge of subject-specific skills and algorithms	Skills used in painting with watercolors, whole-number division algorithm
Cb. Knowledge of subject-specific techniques and methods	Interviewing techniques, scientific method
Cc. Knowledge of criteria for determining when to use appropriate procedures	Criteria used to determine when to apply a procedure involving Newton's second law, criteria used to judge the feasibility of using a particular method to estimate business costs
D. METACOGNITIVE KNOWLEDGE -	Knowledge of cognition in general as well as awareness and knowledge of one's own cognition
Da. Strategic Knowledge	Knowledge of outlining as a means of capturing the structure of a unit of subject matter in a textbook, knowledge of the use of heuristics
Db. Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge	Knowledge of the types of tests particular teachers administer, knowledge of the cognitive demands of different tasks
Dc. Self-knowledge	Knowledge that critiquing essays is a personal strength, whereas writing essays is a personal weakness; awareness of one's own knowledge level

Anderson, L.W., and Krathwohl, D.R. (2001). A Taxonomy for Learning, Teaching, and Assessing, Figure 3.2 (p.29). Reproduced by permission of Pearson Education, Inc.

Fig. 1.1 The knowledge dimension

Within each type of knowledge, the authors identify a number of subtypes: knowledge of terminology, for example, is a subtype of factual knowledge, while strategic knowledge is a subtype of metacognitive knowledge. Examples of each subtype provide even further clarification of the discrete chunks within the subtype: knowledge of the alphabet, for example, is a kind of factual knowledge, while knowledge of planning strategies is a kind of metacognitive knowledge. Altogether, "the knowledge dimension" of the *Taxonomy* comprises 4 types of knowledge, 11 subtypes, and over 60 examples (or sub-subtypes)—a full array of types of information that are both discrete in their specific content and interrelated through the connections of their hierarchy. The array bears a striking resemblance to the hierarchies devised by information scientists such as Soergel (1985) that lay out categories and relationships of particular subjects as a basis for designing information-retrieval systems.

1.2.2 The Cognitive Process Dimension

Figure 1.2 displays Anderson and Krathwohl's (2001) "cognitive process dimension." This dimension—a revision of the "levels of learning" that comprised Bloom's (1956) original *Taxonomy*—lays out six categories of learning arranged in a hierarchy based on complexity: remember, understand, apply, analyze, evaluate, and create. Each of these categories also includes its own subcategories—19 in all—that further delineate the chunks within the categories themselves: classifying is a subcategory of understand, for example, while critiquing is a subcategory of evaluate. Like the taxonomy provided for kinds of knowledge, the one provided for categories of learning mirrors similar work in information science.

To varying degrees, the different types of knowledge support different kinds of processing, but this relationship is obviously flexible: both factual knowledge and metacognitive knowledge can support all six levels, for example, although each is more likely than others to come into play at various levels. The existence of this Web of relationships reflects the connections between content and process, complexity and dynamism, which are characteristic of conceptions of information held by the instructional-design field in general. Heer's (2012) three-dimensional representation of Anderson and Krathwohl's taxonomy both provides a graphic image of this Web and shows examples of links to specific learning outcomes (www.celt.iastate.edu/teaching/RevisedBlooms1.html).

CATEGORIES & COGNITIVE PROCESSES	ALTERNATIVE NAMES	DEFINITIONS AND EXAMPLES
1. REMEMBER – Retrieve relevant knowledge from long-term memory		
1.1 RECOGNIZING	Identifying	Locating knowledge in long-term memory that is consistent with presented material (e.g., Recognize the dates of important events in U.S. history)
1.2 RECALLING	Retrieving	Retrieving relevant knowledge from long-term memory (e.g., Recall the dates of important events in U.S. history)
2. UNDERSTAND – Construct meaning from instructional messages, including oral, written and graphic communication		
2.1 INTERPRETING	Clarifying, paraphrasing, representing, translating	Changing from one form of representation (e.g., numerical) to another (e.g., verbal) (e.g., Paraphrase important speeches and documents)
2.2 EXEMPLIFYING	Illustrating, instantiating	Finding a specific example or illustration of a concept or principle (e.g., Give examples of various artistic painting styles)
2.3 CLASSIFYING	Categorizing, subsuming	Determining that something belongs to a category (e.g., Concept or principle) (e.g., Classify observed or described cases of mental disorders)
2.4 SUMMARIZING	Abstracting, generalizing	Abstracting a general theme or major point(s) (e.g., Write a short summary of the events portrayed on a videotape)
2.5 INFERRING	Concluding, extrapolating, interpolating, predicting	Drawing a logical conclusion from presented information (e.g., In learning a foreign language, infer grammatical principles from examples)
2.6 COMPARING	Contrasting, mapping, matching	Detecting correspondences between two ideas, objects, and the like (e.g., Compare historical events to contemporary situations)
2.7 EXPLAINING	Constructing models	Constructing a cause-and-effect model of a system (e.g., Explain the causes of important 18th-century events in France)
3. APPLY - Carry out or use a procedure in a given situation		
3.1 EXECUTING	Carrying out	Applying a procedure to a familiar task (e.g., Divide one whole number by another whole number, both with multiple digits)
3.2 IMPLEMENTING	Using	Applying a procedure to an unfamiliar task (e.g., Use Newton's second law in situations in which it is appropriate)

Fig. 1.2 The cognitive process dimension