Citation Context Analysis of Theory Use in Instructional Design and Technology Academic Articles

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ABSTRACT

Citations allow researchers to define relationships across articles and develop arguments by building on the work of others. This study explores citation of theory symbols in Instructional Design and Technology (IDT) academic articles. The term *theory symbol* is used to define a concept that, after its original publication, is subsequently incorporated by later writers through citation. Exploring the citation history of the seminal publications makes it possible to trace theory symbol use over time and thus to trace its dissemination in the field. A typology of theory symbol use in IDT academic publication is developed through a citation context analysis (CCA) of a sample of articles published in *Educational Technology Research and Development* (ETRD) and its predecessor journals (1953–2012) which incorporate theory symbols through citation. This analysis contributes to an understanding of how theory has shaped IDT disciplinary knowledge and augments discourse analysis and bibliometrics by examining the context in which theory is incorporated into academic publication.

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GENERAL AUDIENCE ABSTRACT

This study explores the citation of theory symbols in Instructional Design and Technology (IDT) academic articles. A *theory symbol* is a concept that is included in a publication deemed to be foundational to a theory's creation or development and subsequently incorporated by later writers through citation. Exploring the relationships between these cited and citing documents, with specific attention to the content of prior work passed from one to the other, makes it possible to trace the dissemination of theory symbols in the field and develop a typology of theory symbol use in IDT academic publication. This process is called citation context analysis (CCA) (Ritchie, 2008). A sample of articles published in *Educational Technology Research and Development* (ETRD) and its predecessor journals (1953–2012) serves as the foundation of the study. This analysis contributes to an understanding of how theory has shaped IDT disciplinary knowledge by examining the context in which theory is incorporated into academic publication. As Baskerville and Dulipovici (2006) argue, it is valuable to understand the application of theory because theory is used to support research arguments, methodology and in turn the development of other theories.

Dedication

This dissertation is dedicated to my husband,

Mike Gentry,

who has always supported me in pursuit of
my dreams. I love you.

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Chapter 1 - Introduction

In the 1953 inaugural issue of Audio-Visual Communication Review (AVCR), one of the predecessor journals to Educational Technology Research and Development (ETRD), Edgar Dale (1953)argued for "rigorous, analytic and systematic [sic], objective study" (p. 5) and the close alignment of research and theory. Sixty years later, the discipline of Instructional Design and Technology (IDT) continues to be influenced by research, theory, and practice (Richey, Klein, & Tracey, 2011) and the related "web of relationships among knowledge, inquiry, practice, and learning" (Jenlink, 2006, p. 60). Writing is a critical step in the IDT research process. "By generating theoretically relevant insights, and writing them out on paper, we are able to work out how the...yideas of our disciplinary community interact" (Golden-Biddle & Locke, 2007, p. 115). Through these writings, researchers become members of the scholarly community (Kamler & Thomson, 2006) and influence the direction of a discipline by building on the work of others.

As a theory is developed, theoretical construct networks become interrelated, with other constructs connected around it (Stepin, 2005) to form a "network of relations" (Stepin, 2005, p. 376). Researchers build foundations for new conceptual arguments by citing theory in academic publication (Richey et al., 2011; Sutton & Staw, 1995). This may be considered a "labelling process" in which writers give meaning to prior work by sharing concepts contained in an original source, as well as details for locating it (Small, 1978, p. 328). In doing so, citations become symbols for the concepts expressed in prior work (Small, 1978). In this study, the term *theory symbol* is used to describe a concept which is first expressed by an author in a publication deemed to be foundational to a theory's creation or development and subsequently incorporated by later writers through citation.

Despite the influence that researchers have in shaping a discipline's development through the creation and development of theory, "surprisingly little specific consideration has been given to the work of theories in the social construction of knowledge" (Martens, 2004, p. 1). Presuming with Mizruchi & Fein (1999), that that disciplinary knowledge is "socially constructed through the selective interpretation" of cited prior work (p. 653), this research explores the citation history of seminal publications, that is, those deemed significant in the creation or development of a theory, and thus makes it possible to trace theory symbol use over time. Results are presented in a typology of theory symbol use.

Need for the Study

While there is a wide range of research about theory and the role it plays in advancing disciplinary knowledge, there is a lack of research addressing how theory has contributed to the development of IDT through academic publication. Researchers recommend that future efforts explore areas such as the application of theoretical concepts, the communication of theory in academic publication, and the impact a researcher's work has had on the development of other theories (Bort & Kieser, 2011; Martens, 2004). While researchers have traced citations made to articles about theory, these studies have focused on the citation counts and citation patterns across disciplines rather than on the content which is incorporated through citation. Pettigrew and McKechnie (2001) recommend that researchers explore the content incorporated through citation and classify the application of theory in academic publication as either cursory or substantive. Jacobson (2007) argues for research to compare "knowledge producers and knowledge users…to determine which relevant voices might not have been heard, and thus what knowledge was not transferred" (p. 124).

Following these recommendations, this research explored the application of theory at the point of citation and provides a typology to make visible the differing ways that theory is incorporated into IDT academic publication.

This study also followed recommendations by White (2004) and Swales (1986) to simultaneously explore citation through hetorical analysis, citation classification, and the analysis of citation contexts. Following their advice, literature from three influential disciplines (applied linguistics, information science, and the sociology of science), served as the foundation for the literature review and research methodology.

As White (2004) explains, blending the approaches of "rhetorical analysis of citation within documents and bibliometric analysis across documents" provides an opportunity to "give the still-disheveled theory of citing a whole new look" (p. 112). "[S]ynthesis is warranted," he continues:

> It is not as if the literatures from the different traditions were wholly separate and could only be joined through massive reading; many researchers have already perceived connections. What is missing is a new study that would unite the findings and arguments of the various writings under discourse-analytic headings. The specific goal would be to explain as much of citation as possible by integrating rhetorical analysis with the psychological, sociological, and bibliometrics treatments seen to date. (p. 112)

This research, sought to make headway towards addressing these identified gaps.

Purpose Statement of the Study

The purpose of this study was to trace theory symbol use over time by exploring the citation history of seminal publications and to provide a typology of theory symbol use in IDT academic publication.

Conceptual Framework

The conceptual framework for this study brings together the concepts of discourse, theory, and citation. The combined influence of these components on IDT disciplinary knowledge are discussed through the lens of systems theory. Systems theory is concerned with the relationships among individual components that form a whole (Watson & Reigeluth, 2008) (Watson & Reigelugh, 2008) and enables the exploration of the interactive processes of individual system components as well as their impact on the entire system (Banathy, 1967; Gagne, 1962). The hierarchical structure of the system aligns with Fairclough's (1992) three dimensions of discourse: text, discursive practice, and social practice. The second area of focus concerns the application of theory at the point of citation, known as the application context (Martens, 2004; Martens & Goodrum, 2006). The final area of focus, citation, entails the collection of words and indexing methods which correlate to a list of references, included at the end of the document, which provides details for locating the original source (Borgman, 1989; Powley & Dale, 2007). Together, discourse, theory, and citation serve as a framework to explore disciplinary knowledge and serve as the foundation for a typology of theory symbol use in IDT academic publication.

Research Questions

1. Which publications cited in ETRD qualify as *seminal*, that is, deemed to be foundational to a theory's creation or development over time?
2. What patterns of theory symbol use emerge when references in ETRD to seminal publications are traced over time?
3. How can emergent patterns support a typology of theory symbol use in IDT academic publication?

Key Terms

Bibliometrics. Bibliometrics explores relationships between bibliographic elements included in publication such as authors, journals, and articles (Havemann & Scharnhorst, 2010).

Disciplinary knowledge. Following the definition of knowledge base, disciplinary knowledge is described as "what a field has learned about itself over time" (Richey et al., 2011, p. 4).

Citation context analysis. This study falls within the combined categories of citation context classification, used to identify relationships between the cited and citing documents, and citation content analysis, which explores the content of prior work which is incorporated through citation (Ritchie, 2008). Taken together, these categories may be referred to as citation context analysis (CCA) (Ritchie, 2008).

Discourse. Discourse is defined as a "systematically organized sets of statements which give expression to the meanings and values of an institution" (Kress, 1989, p. 7).

Theory. Theory is integrated principles which attempt to explain and predict phenomena (Reigeluth, 1983b).

Theory symbol. The definition for the term *theory symbol* in the context of citation was created by building on Borgman (1989), Hyland (1999), Small (1978), and Powley and Dale (2007). The term *theory symbol* is used to define a concept which is expressed by an author in a seminal publication. A *seminal publication* is defined as one deemed to be foundational to a theory's creation or development and subsequently incorporated by a later writer through citation. Following Small (1978), in the context of citation the term *concept* refers to "any statement which may be taken as characterizing or describing the cited document" (p. 329). The terms *author* and *writer* follow Hyland (1999) in which an *author* is defined as a person whose work is being cited and a *writer* refers to the person doing the citing. Finally, *citation* is the collection of words and indexing methods, such as the author and publication year, which correlates to a list of references; in contrast a *reference* is included at the end of a document and provides details for locating the original source (Borgman, 1989; Powley & Dale, 2007).

Typology. A typology is a classification or grouping (Bailey, 1994) which can serve as a framework to support future empirical study.

Benefits of the Study

This research explored the application of theory at the point of citation and provides a typology to make visible the differing ways that theory is incorporated into IDT academic publication. A typology is a classification or grouping (Bailey, 1994) which can be used as a framework to support later research in empirical studies. A better understanding of the application of theory through citation will alert IDT researchers to theories that may have become overlooked over time, and the mix of theories that have come in and out of favor. This provides an opportunity for researchers, experienced and novice alike, to reflect on their own practice and consider how their efforts have influenced the direction of the discipline and what changes they can make going forward to benefit IDT research and practice. A classification provides “breadth analysis” while enabling “depth analysis” (Baskerville & Dulipovici, 2006, p. 100). For example, pairing these findings with external factors such as educational policy and research in neighboring disciplines may reveal the reactive and proactive nature IDT research and the ways the discipline influences and is influenced by other factors. Equipped with a better understanding of these dynamics, disciplinary leaders can better support educational change.

Chapter 2 - Review of Literature

This chapter situates discourse, citation, and theory within the larger system of IDT disciplinary knowledge and provides a summary of related research. The discussion is guided by literature from applied linguistics, information science, and the sociology of science, each of which share a common tradition in citation analysis (Swales, 1986; White, 2004). The first section introduces a Complex Adaptive System (CAS) as a framework to explore IDT disciplinary knowledge. Applying this framework, the second section describes IDT disciplinary knowledge, including its boundaries and the three components that serves as a foundation of theory symbol use in IDT academic publication (discourse, citation, and theory). The next section provides a summary of prior related research that supports the development of a typology. The final section identifies the research gap to be addressed by this study.

A Complex Adaptive System Framework for Exploring IDT Disciplinary Knowledge

In this section, IDT disciplinary knowledge is explained within the context of a Complex Adaptive Systems (CAS). A systems framework supports the exploration of "theories and methods of praxis from various disciplines" (Saba, 2007, p. 53), provides an explanation of the emergence of knowledge, and underlines the importance of collaboration between individuals and a collective" (Kimmerle, Moskaliuk, Cress, & Thiel, 2011). Similarly, disciplinary knowledge is an output of academic discourse which is described as "the ways of thinking and using language" which build the "social roles and relationships which create academics and students and which sustain the universities, the disciplines, and the creation of knowledge itself" (Hyland, 2009, p. 1). These similarities underscore the value of examining these topics in unison.

Systems theory is concerned with the relationships among components that form a whole (Watson & Reigelugh, 2008) and enabled the exploration of the function and interactive processes of individual system components as well as their impact on the entire system (Banathy, 1967; Gagne, 1962). The term *complex* comes from the Latin term "*complexus*, meaning to entwine"; used as an adjective for a system it refers to "interconnected or interwoven parts" (Boardman & Sauser, 2008, p. 188). Systems theory and CAS have been applied to educational policy (Maroulis, Guimera, Petry, Stringer, Gomez, Amaral, & Wilensky, 2010) instructional design, education (Banathy, 1988, 1992; Stephens & Richey, 2011), theory building (Saba, 2007), distance education (Moore, 2012), social systems (Bar-Yam, 2004), social organizations (Gell-Mann, 1994) and linguistics (Cameron & Larsen-Freeman, 2007).

According to Marion and Uhl-Bien (2007), there are two schools of thought among complexity theorists: the American school, centering on research from the Santa Fe Institute which focuses on the internal relationships within the network, and the European school, emerging from Nobel prize winner Ilya Prigogine's research and focusing on network destabilization. The present study concerns the relationships between components that support the production of disciplinary knowledge and as such incorporates the work of Murray Gell-Mann, a Distinguished Fellow at the Santa Fe Institute. Heeding Cameron and Larsen-Freeman (2007) warning that one cannot "claim that real-world systems are actually complex systems with the mathematical constraints and requirements that entails" (p. 228) This study aims only to offer a model for describing how citations support the development of disciplinary knowledge using this framework as a foundation.

IDT Disciplinary Knowledge Overview

This section describes the boundaries of IDT disciplinary knowledge and defines the three components applicable to this study (discourse, citation, and theory) through the lens of a CAS. Taken together, these elements serve as the foundation for a typology of theory symbol use in IDT academic publication.

Boundaries of IDT Disciplinary Knowledge

According to Klahr (2002),"A common strategy for understanding a complex system is to explore its behavior at the boundaries" (p. 3). System boundaries define areas of interest within a wider context and are identifiable through the system's components (Boardman & Sauser, 2008; Saba, 2007). This discussion of the boundary for the CAS of IDT disciplinary knowledge begins with the definition of discipline and disciplinary knowledge.

Discipline of IDT. In this study, references made to the discipline of IDT relate to Becher and Trowler (2001) description of a discipline as an academic, knowledge community, often identifiable by the boundary of an academic department (Becher & Trowler, 2001). Communities "are recognizable by the practices of those who belong in them" and can be considered complex systems (Sealey & Carter, 2004, p. 131).

Disciplines provide a framework for shared tools, language, and concepts (Schoenberger, 2001) and in doing so mold identities, peer groups, and career trajectories. Disciplines are in constant flux and comprised of different methodological and theoretical approaches (Reich & Reich, 2006; Schoenberger, 2001). A discipline's autonomy is dependent upon its ability to maintain boundaries and conditions for participation such as obtaining a Ph.D. in the discipline and contributing to the advancement of knowledge through academic publication (Medina, 2013).

Elen (1998) describes instructional design as both a profession and a discipline. As a profession, it is concerned with the design and development of instruction. As a discipline, it is focused on "constructing models that reveal the structure of instructional products and design/development processes" (Elen, 1998, p. 281). The dual emphasis on both practice and research is a common theme among definitions of IDT. For example, Richey et al. (2011) define instructional design as "the science and art of creating detailed specifications for the development, evaluation, and maintenance of situations which facilitate learning and performance" (p. 3).

IDT disciplinary knowledge. IDT may be described as a practice science in that its knowledge base is shaped by both theoretical and practical components (Richey et al., 2011). Wallace (1983) distinguishes between these two types of knowledge in explaining that "theoretical knowledge has for its end the attainment of truth and that alone, whereas practical knowledge seeks truth as a means to an end, so as to order it to practice or operation" (p. 273). Simply stated, "a knowledge base is what a field has learned about itself over time" (Richey et al., 2011, p. 4). In this study, the IDT knowledge base is referred to as *IDT disciplinary knowledge*.

Disciplinary knowledge is socially constructed (Becher & Trowler, 2001) through the collective effort of those researching and working within an area of study (Richey et al., 2011). Academic publication plays a key role in the production and dissemination of disciplinary knowledge. Disciplinary knowledge is connected to publication in the form of academic journals which carry the discipline's knowledge through citation (Fujigaki, 1998). Through chains of citations, journal articles form a network of publication, continually incorporating prior work into publication and incrementally building on their findings. Publication "builds its own walls—

the boundary between science and society, the boundary between science and non-science . . . and the boundaries of the discipline" as a result of the ongoing operation of the system (Fujigaki, 1998, p. 10). When articles include citations from another consistent set of related journals, clusters are created from these citing relationships (Leydesdorff, Cozzens, & Van den Besselaar, 1994) and results in additional boundaries between scientific and nonscientific journals (Fujigaki, 1998).

Components of Disciplinary Knowledge that Serve as a Foundation for a Typology of Theory Symbol Use in IDT Academic Publication

Three critical components that situate theoretically based citation within the larger system of IDT disciplinary knowledge production and serve as a foundation for typology of theory symbol use include discourse, citation, and theory. An introduction to these concepts and the role that each plays in the production of disciplinary knowledge is explored in the sections that follow. The definition of the term *theory symbol* in the context of citation is also provided.

Discourse. Discourse may be described as "systematically organized sets of statements which give expression to the meanings and values of an institution" (Kress, 1989, p. 7). Discourse is situated in a social practice. A social practice is described as a "stabilized form of social activity" (Fairclough, 2003, p. 205) such as committee meetings, lectures, and publication, each of which has its own set of "rules or conventions" which dictate behavior (Gee, 2014, p. 5).

Discourse as a hierarchical structure. The components and sub-components of a CAS are arranged in a hierarchy (Eidelson, 1997) and may be described as "sets of boxes nesting within sets of boxes . . . often to a considerable number of repetitions" (Simon, 1995, p. 26). Due to its nested structure, the CAS network is best explored at the lowest level at which the components related to the research questions are distinguishable (Holland, 1995). Within a system, lower level components move more quickly than higher level components and the interaction between the levels defines the dynamics and evolution of the system (Liljenstrom & Svedin, 2005).

The hierarchical structure of disciplinary knowledge aligns with Fairclough's (1992) three dimensions of discourse: text, discursive practice, and social practice (see Figure 1).

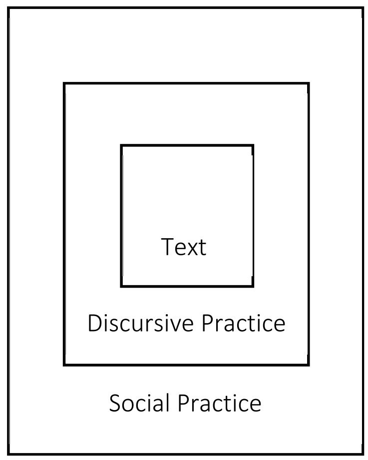

Figure 1. Fairclough's three-dimensions of discourse as nested boxes (Fairclough, 1992, p. 73).

As Kamler and Thomson (2006) explain, "this model . . . provides a powerful visual heuristic for representing both the effects of broader social contexts on writing and the way writing itself is a form of social interaction, embedded in institutions and social structures" (p. 20). The model is based on the premise that text can only be understood when it is considered in relation to other texts and the broader social context (Jorgensen & Phillips, 2002). Along similar lines, Ruiz (2009) argues that discourse "must first be analyzed from both a textual and contextual approach" in order to interpret discourse within a broader social context. Seeking to advance understanding of how theory has impacted the broader context of IDT disciplinary knowledge, the present study explores theory citation of theory symbols in academic articles.

Text dimension of discourse. At the lowest level, the text dimension refers to written and spoken forms of communication used to support interaction (Fairclough, 2003). Analysis for this study focuses on linguistic features, such as wording and the way that other texts are incorporated (Fairclough, 1992, 2003) within citation contexts. The exploration of citation context can reveal the influence of prior work on subsequent research (Paul, 2000). For example, Winsor (1993) combines an analysis of citation patterns and the rhetorical use of citations, finding that a widely cited, controversial article in biology is often incorporated in academic articles without real acceptance of its core arguments. Examining the context of citations, that is the text surrounding citations, Small and Greenlee (1980) concluded that articles which are highly cited are generally cited in relation to a single central idea that the original article introduces. However, Cozzens (1982) finds that articles can have a "split citation identity" representing two distinct concepts over time (p. 233).

Discursive practice dimension of discourse. The discursive practice dimension serves to mediate the relationship between the text and social practice dimensions; "hence it is only through the discursive practice—whereby people use language to produce and consume texts—that texts shape and are shaped by social practice" (Jorgensen & Phillips, 2002, p. 69). Through writing, researchers become members of the scholarly community (Kamler & Thomson, 2006) and influence the direction of an area of study by building on the work of others.

The continued citation of a published source is not meant to imply that all scholars consider the published research findings be useful in the same way and at the same time; instead, some ideas may appeal to scholars more than others, and some ideas may be favored at different points in time or in certain disciplines or regions of the world (March, 2007). As Köhler (1971/1913) explains,

> Each science has a sort of attic into which things are almost automatically pushed that cannot be used at the moment, that do not quite fit, or that no one wants to investigate at the moment…We are constantly putting aside, unused, a wealth of the most valuable materials. (p. 29)

Social practice dimension of discourse. Societal practice is the broader context in which the text is produced, which according to (Kamler & Thomson, 2006, p. 21) "includes specific academic and disciplinary practices as well as the broader relations of power and domination which shape university cultures and practices" (Kamler & Thomson, 2006, p. 21). For example, researchers must apply diverse discipline-specific facts related to "procedures, instrumentation, experimental paradigms, and data-analytic methods" (Klahr, 2002, pp. 12-13). The study focuses on a single discipline and journal.

Citation. A citation is the collection of words and indexing methods, such as the author and publication year, which correlates to a list of references (Borgman, 1989; Powley & Dale, 2007). Citations may be described from conflicting viewpoints. From one viewpoint, citations are situated in both "a rhetorical system, through which scientists try to persuade each other of their knowledge claims; and a reward system, through which credit for achievements is allocated" (Cozzens, 1989, p. 440). According to this viewpoint, the ownership of science is shared by a community, and researchers seek to publish in order to claim credit for an idea. Those of the other viewpoint consider "personally discovered knowledge as belonging unequivocally to themselves" (Cronin, 1984, p. 82). Researchers are associated with their published ideas, and citations allow the community of researchers to acknowledge their "intellectual debts to the discoverer, just as payments on a licensing agreement acknowledge economic indebtedness to the inventor" (Cozzens, 1989, pp. 439-440). In addition to good etiquette, citations can also represent the “war of words” in which “publications are weapons in a struggle among scientists to persuade each other of the validity of knowledge claims, and thereby to establish dominant positions in the community” (p. 440).

Citation as a boundary object. Research findings and communication among researchers play a key role in the production of disciplinary knowledge, but as Star and Griesemer (1989) explain, this process is more complex than it may first appear:

> because these new objects and methods mean different things in different worlds, actors are faced with the task of reconciling these meanings if they wish to cooperate. This reconciliation requires substantial labour on everyone’s part. Scientists and other actors contributing to science translate, negotiate, debate, triangulate, and simplify in order to work together. (p. 388-389)

Medina (2013) argues that the differences between social worlds highlight the value of “negotiation and debate” which occurs between actors and allow for cooperation across borders without general agreement (Merton, 1973, p. 36).

These processes are facilitated by boundary objects—a term used to describe objects that “maintain a common identity” even when adapted for varied target settings—and play a critical role in “developing and maintaining coherence across intersecting social worlds” (Star & Griesemer, 1989, p. 393). The four types of boundary objects, which Star and Griesemer (1989) describe as repositories, ideal, coincident, and standardized (see Table 1). Library databases, citations, research articles, and standardized citation practices are all examples of boundary objects (Martens, 2004).

Table 1

Summary of Star and Griesemer's Four Kinds of Boundary Objects

Type	Description	Example
Coincident	Objects with identical boundaries and varying internal contents (Star & Griesemer, 1989)	Research articles published in ETRD which must adhere to format and editorial requirements and in doing so support the literature review process
Ideal	Objects which are "abstracted from all domains and may be fairly vague" (Star & Griesemer, 1989, p. 410)	Citations which facilitate communication across boundaries by carrying information from one research article to another (Martens, 2004)
Repositories	Collections of objects which are made accessible through standardization (Star & Griesemer, 1989)	Library databases which support research practices, such as the Web of Science or JSTOR where articles published in ETRD may be located
Standardized	Objects which link communities and support collaborative efforts through the application of common methods (Wenger, 1998)	Citations which adhere to ethical and standardized practices such as those established by the American Psychological Association (APA)

Citation as a feedback mechanism. The success of an individual researcher is measured by the quality and quantity of publication (Merton, 1973). Publication quality is difficult to measure because it cannot be determined solely through the examination of the published ideas, but is instead based on what other researchers do with the published ideas (Latour, 1987). While the quantity of publication is easier to determine, Merton cautions that the pressure for publication can "transform the sheer number of publications into a ritualized measure of scientific or scholarly accomplishment" (Merton, 1973, p. 316). Nonetheless, the number of researchers who utilize a published idea through citation is used as a gauge to identify "good" science (Latour, 1987, p. 61). Acknowledging another researcher through citation allows a writer to persuade community members, justify arguments (Gilbert, 1977), identify research gaps, and exhibit allegiance to a select community (Hyland, 2004). By connecting prior work to these new frameworks, citation serves as a feedback mechanism which plays a central role in the social construction of knowledge.

Complex systems have time-delayed feedback loops (Liljenstrom & Svedin, 2005) which reveals the system's behavior (Guttman, 1991). As information from publications is incorporated by a researcher through citation, it serves to influence not only the author whose work was cited but others researchers who in turn build upon the combination of new and cited work. Because "language is a vehicle for expressing the concepts and values of academic knowledge" (Parry, 1998, p. 273), publication can lead to disagreement among researchers. However, "it is the spice of scholarly debate that gives a publication like ETRD the energy to evolve and thus to survive for many long years" (Winn, 1989, p. 44).

Positive feedback is information which results in a system deviating from its original state, whereas negative feedback brings a system back to its original state (Guttman, 1991). An example of positive feedback is the lock-in or competency trap in which the more an individual follows a rule the less incentive he or she will have to apply another rule even if it may potentially provide a better outcome (March, 1994). For example, once a researcher develops skills in applying a specific theory or research methodology, he or she has less incentive to apply alternative approaches. Change would expose the researcher to "diminished success until proficiency improves" (Eidelson, 1997, p. 49).

Citation as argument. Scientific thinking, a form of problem solving, is formed through the coordination of theory and evidence through the process of argumentation (Belland, 2013; Kuhn & Pearsall, 2000). Argumentation is the process researchers use to generate theory, challenge and support claims, communicate and refine knowledge, refute criticisms, and solve ill-structured problems (Belland, Glazewski, & Richardson, 2008; Golanics & Nussbaum, 2008; Jonassen, 2011; Osborne, 2010; Toulmin, Rieke, & Janik, 1979; vonAufschnaiter, Erduran, Osborne, & Simon, 2008). In academic publication, knowledge claims are supported with arguments shared through citation at the sentence level (Cozzens, 1989; Toulmin, 2003), the lowest level of analysis applied in this study. An argument is a series of statements to support a conclusion and a term which serves as a signpost which directs the reader (Lumer, 2005).

Theory. Theory may be defined as integrated principles which attempt to explain and predict phenomena (Reigeluth, 1983b). Theories provide a systematic approach for exploring problems; in contrast, models present a simplified representation of a construct in order to support understanding (Sackney & Mergel, 2007). Theories may become the focus of debate and modified over time to incorporate new findings *(Yearley, 1988)*. As *Yearley (1988)* explains, exploration of scientific debates emphasizes the "outcome of disputes" but "should instead be focused on the process of debate" (p. 351). He explains that debates include claims and counter-claims, but a focus on the outcome of the debate causes one to lose these steps and counter-steps which together form the outcome of the argument. However, a disadvantage of focusing on the process is a loss of attention to the argument's truth. The process focus could lead one to embrace a "false conclusion" rather than a true conclusion (p. 352).

Theory as schemata. Schemata support the functioning of a CAS. In considering society to be a CAS, an example of schemata includes traditions and laws (Gell-Mann, 2002). According to Gell-Mann (2002), theory is the schema of scientific study. "A schema, although it has to have some degree of stability or robustness, must also be capable of changing, of undergoing mutation or replacement by another schema" (Gell-Mann, 2002, p. 18). Similarly, theories that are able to make predictions are likely to survive; in contrast, when research results repeatedly oppose the theory (feedback), then the theory is likely to be modified or exchanged for another (Gell-Mann, 2002).

Theory as a network member. Theory construction can be regarded as a "network of relations" used to support a hypothesis (Stepin, 2005, p. 376). For example, the construction of inductive theory often starts with a hypothesis formed from "theoretical concepts which are not yet organized into theoretical frameworks but are prominent in the thinking and research of a discipline" (Richey et al., 2011, p. 7). In contrast, deductive theories are constructed through logic and assumptions which are often rooted in empirical data which have been tested and validated (Richey et al., 2011). In order to gain the attention of other researchers and establish a new theoretical direction, a theory "must differ significantly from, and at the same time be connected to, established literature in order to be seen as meaningful" (Alvesson & Sandberg, 2011, p. 247).

Theory construction is influenced by the context of its application, the theoretical foundation of the discipline (Elen & Clarebout, 2008), dominant research paradigms, citation patterns, and scientific writing norms (Bowring, 2000). IDT resembles a practice science in that it is influenced by practice, research, and theory (Richey et al., 2011). When these efforts are combined, theory developed through research and knowledge gained through practitioner experience form the methods and resources which scholar-practitioners use to interact "in the complex web of relationships among knowledge, inquiry, practice, and learning" (Jenlink, 2006, p. 60).

There exists a "cooperative interdependence of communities of scholars" in which "the continual flow of ideas, interpretations, and elaborations within the scholarly community makes it an exercise in fabrication to isolate any one contribution or contributor as separable from many others" (March, 2007, pp. 537, 538). As theories are developed, theoretical construct networks become interrelated, with other constructs connected around it (Stepin, 2005). As a result, theories “are at some point not only innovations but ideally, within their epistemic communities, innovation-generators” (Martens, 2004, p. 3).

Theory as argument. The incorporation of theory into academic publication through citation contributes to a discipline’s development. This process is initiated by a researcher during an investigation (M. Anderson, 2006), influenced by the decisions made about which theories to incorporate into the study (Astley, 1985), and continues to be shaped by reviewers and editors after submission for publication (M. Anderson, 2006).

Citing theory developed in prior work can help researchers build a foundation for new conceptual arguments and develop hypotheses (Richey et al., 2011; Sutton & Staw, 1995). But because researchers choose which citations to include or exclude, the final research document becomes a reflection of his or her “view of reality” (Kamler & Thomson, 2006, p. 11). Jacobson (2007) argues that when exploring interactions between knowledge producers and users it is valuable to identify what knowledge was not transferred. Once an article is published and shared with the scholarly community, the original researcher’s intention is no longer relevant (Ricoeur, 1973) and a distorted interpretation of the work may end up being used to build new conceptual arguments through citation. Astley (1985) explains that several interpretations may be made of the same phenomenon.

As Alvesson and Sandberg (2011) explain, “identifying and challenging the assumptions underlying existing theories . . . appears to be a central ingredient in the development of more interesting and influential theories” (p. 247). However, Pfeffer (1982) cautions against the aimless application of theory in explaining that unresolved disputes related to a theory can lead to a discipline beginning to “resemble more of a weed patch than a well-tended garden” when it becomes difficult to determine the direction of knowledge (p. 1). This view highlights the significance of publication as not just a method of communication, but as a method of encouraging community members to consider alternative theories while also working towards consensus.

Prior Related Research that Supports a Typology of Theory Symbol Use in IDT Academic Publication

The prior section introduced the elements of IDT disciplinary knowledge that serve as the foundation for a typology of theory symbol use in IDT academic publication including discourse, theory, and citation. In this section, the intersection of these elements are explored through prior research including theory context studies and citation context studies.

Theory Context Studies

Research studies about theory fall into two major categories: career and context (Martens, 2004; Martens & Goodrum, 2006). Career studies relate to a single theory's history and may include discussions of competing or preceding theories, whereas context studies explore specific characteristics of a theory or theories (Martens, 2004). This section introduces prior research related to theory context, the category applicable to this study, with the shaded boxes indicating applicable categories (see Figure 2).

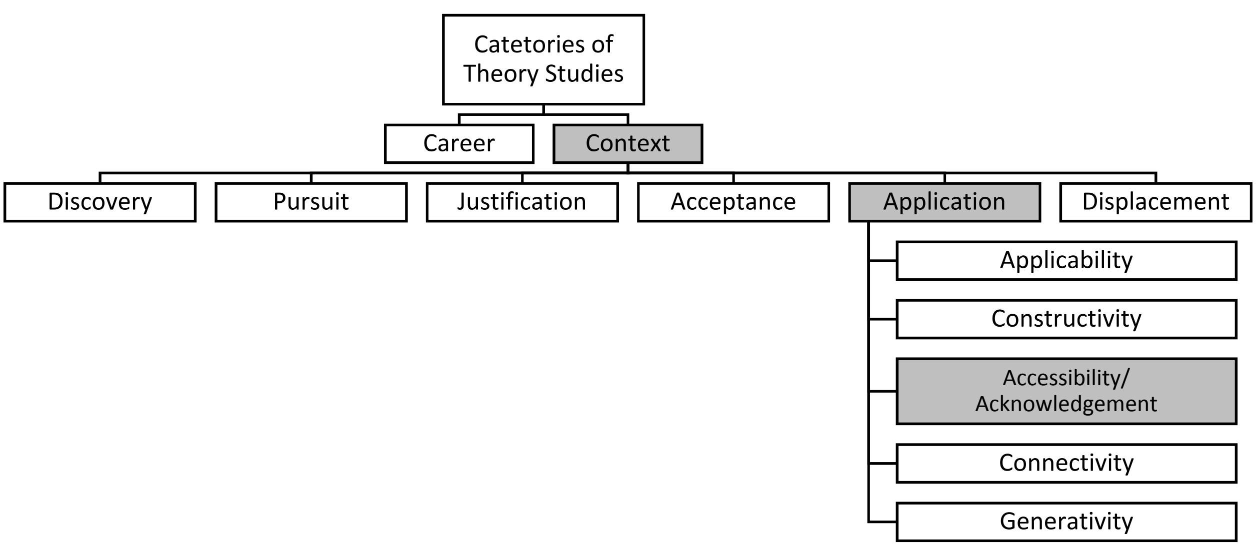

Figure 2. Categories of Theory Studies (Martens, 2004; Martens & Goodrum, 2005)

Theory context studies. Martens (2004) details six categories of theory context studies: discovery, pursuit, justification, acceptance, application, and displacement. Considering these categories as stages in the lifecycle of a theory can aid in understanding. The current research study aligns with the application context of theory—specifically how theory symbols are used in IDT academic publication argumentation.

Theory application context studies. Research related to the application context of theory includes the exploration of factors which facilitate its influence as revealed through its application and resulting influence as revealed through diffusion (Martens, 2004). According to Dulipovici and Baskerville (2013), the application of theory includes both scientific and social processes. These processes occur simultaneously and include such tasks as using prior research to support a new endeavor and submitting a manuscript for peer review and publication. These processes continue when researchers within the community read the publication and use it to advance their work. This latter stage is what Dulipovici and Baskerville refer to as *eduction*. Eduction is a creative process which involves the process of "drawing forth, eliciting, or developing ideas from a state of latent, rudimentary, or potential existence" (Baskerville, 2007, p. 323).

Researchers have explored the factors which influence the application of theory through the scientific and social processes of eduction with conflicting findings. For example, Bort and Kieser (2011) investigated the application theoretical concepts, finding evidence that an author's reputation and

> the prestige of the journal in which a concept is published the first time does not have a significant impact on the rate of diffusion of a particular concept while the prestige of the

> journals in which a concept is published later has significant positive effect on the diffusion rate. (p. 674)

They explain that these results are contrary to prior research which indicated that the quality of the original publication, was a more important factor in impacting diffusion than the quantity of publications. They also find that the diffusion of concepts related to a theory is positively influenced by the popularity of the theory itself. Consider too that academic publication requires that manuscripts are reviewed by gatekeepers (Metoyer-Duran, 1993) which includes in the justification context of theory (Martens, 2004). This reveals the close relationships that exist between the categories of theory context studies.

Baskerville and Dulipovici (2006) developed a taxonomy of theory use in academic publication to reveal the ways in which theory is used to define, justify, and evaluate knowledge management practices. They identified a series of influencing subject areas, related theoretical frameworks, and “overarching theories” in order to understand how theory has been applied in academic publication to advance the field over a 20 year period (p. 99). They conclude that the field is influenced through the extension of its own theoretical base as well as the application of theories from other disciplines.

Building on this study, Dulipovici and Baskerville (2013) explore how and why concepts are incorporated from other theories within the field and from other disciplines. They use nine references based on frequency which they had previously identified (Baskerville & Dulipovici, 2006) . For each of the nine references, a sample of 100 articles citing the seminal citations were selected and coded to identify the foundational discipline. Citation analysis revealed two cycles of eduction which serve to incorporate influences from other disciplines as well as contributes to its own disciplinary foundation.

McCain (2011) provides a review of studies which trace the flow of knowledge both within and beyond disciplines. For example, by tracing citations, researchers have explored the theory use across disciplinary boundaries (Oehler, 1990) and the application of concepts included in influential articles (Sarafoglou & Paelinck, 2008). Pettigrew and McKechnie (2001) recognized that little attention had been given to identifying which theories were cited and how they were incorporated into citing articles. They studied how information science theory is used both inside and outside the discipline. Through the quantitative and content analysis of 1,160 articles published between 1993 and 1998 in six information science journals, they identified leading theories. These results were used to search the ISI database and identify 2,098 citations which they called “authority reference(s)” (p. 67) related to those theories. The research revealed an increase in the use of information science theories over time and the finding that many authors incorporate multiple theories into single publications.

There are qualities that allow some theories to be applied more readily throughout the eduction process than others. For example, T. S. Kuhn (1977) suggests that “accuracy, consistency, scope, simplicity, and fruitfulness” form the basis for theory selection (p. 322). Martens (2004) extensive review of eight human sciences theories over 15 to 20 years supplemented by interviews with theorists resulted in the development of five characteristics of theories which influence their selection (see Table 2).

Table 2

Characteristics of Theories

Characteristic	Description
Applicability	How applicable is this theory to a wide variety of phenomena?
	How salient are the phenomena?
Constructivity	Are the constructs and variables defined so as to facilitate testing or replication?
Accessibility/ Acknowledgement	How easy is this theory to understand and utilize?
	How important is it to the discipline as a whole?
	What types of publications channels have carried it? How else has this theory been communicated?
Connectivity	How does this theory fit into existing theoretical frameworks?
Generativity	Has this theory generated a new theoretical framework or new uses for the theory?

Note. Adapted from Martens (2004, p. 135) and Martens (2005).

This dissertation aligns with the accessibility characteristic of theory also referred to as "acknowledgement" within a form of "theoretic communication" such as academic publication (Martens, 2004, p. 131). Accessibility may be studied through citation context analysis (CCA) (Martens, 2004); the methodology applied in this dissertation will be described in Chapter 3.

Citation Context Studies

Bibliometrics, also referred to as citation analysis, explores relationships between bibliographic elements included in publication such as authors, journals, and articles (Havemann & Scharnhorst, 2010). Borgman and Furner (2002) offer four broad categories of citation studies: writing, submission, collaboration, and linking. The writing category relates to decisions to write documents submission focuses on decisions about the journal submission process, collaboration addresses decisions to collaborate with others, and the linking category focuses on decisions to cite other documents and by doing so to create links between them. This study aligns with the linking category and the related subcategories reflected as shaded boxes (see Figure 3).

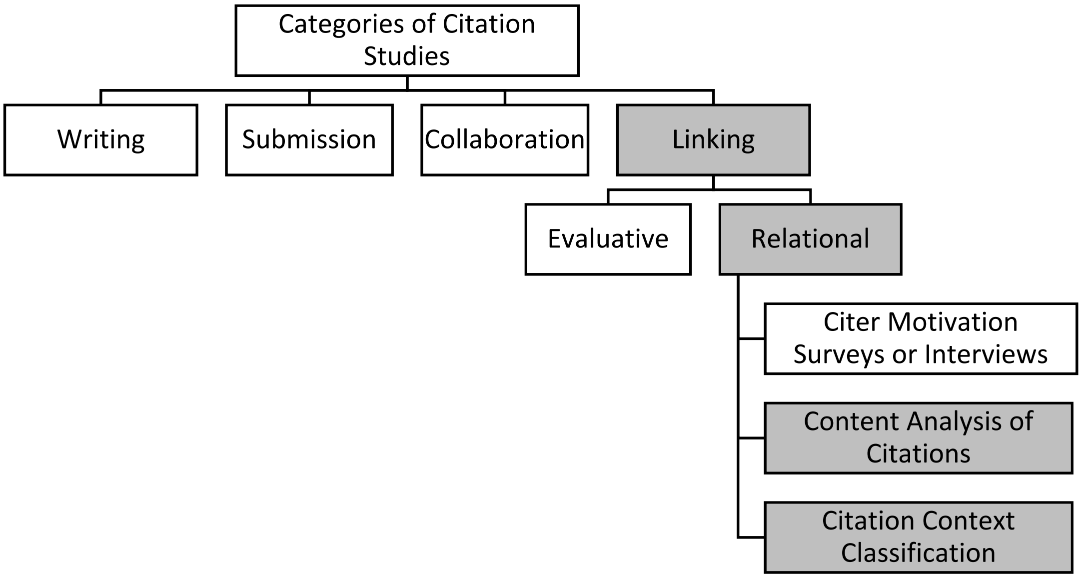

Figure 3. Categories of Citation Studies. (Borgman & Furner, 2002; Ritchie, 2008)

Linking Bibliometrics

Linking bibliometrics focused on connections between documents. Two categories of linking bibliometrics analysis include: evaluative bibliometrics which use citation counts as indicators of influence and quality in scholarly work and relational bibliometrics which explore "links in context" to reveal the flow of information and strength of relationships (Borgman & Furner, 2002, p. 5). In evaluative bibliometrics, citation counts are used as indicators of influence, importance, and quality of authors, articles, journals, areas of focus, and disciplines and do not take into account the direction of the information flow and relationships between the cited and citing articles (Borgman & Furner, 2002). Given this study's interest in the context of citation, relational bibliometrics are the more relevant form of linking bibliometrics.

Relational bibliometrics. Relational bibliometrics, which explored the direction of the information flow and relationships between the cited and citing articles (Borgman & Furner, 2002), can be segmented into three broad classifications: citer motivation surveys and interviews (White, 2004), citation context classification (Small, 1982), and citation content analysis (Small, 1982). These classifications are not mutually exclusive and have been applied in citation study literature reviews by Angrosh (2012), Bornmann and Daniel (2008), Liu (1993), and Ritchie (2008). Research related to this study falls within the combined categories of citation context classification, used to identify relationships between the cited and citing documents, and citation content analysis, which explores the content of prior work which is incorporated through citation (Ritchie, 2008). Taken together, these categories may be referred to as citation context analysis (CCA) (Ritchie, 2008).

By exploring the context of citations, researchers can uncover relationships between the cited and citing articles (Borgman & Furner, 2002) in order to classify citations (Bornmann & Daniel, 2008), identify citation function (Bornmann & Daniel, 2008), assess citation quality (Liu, 1993), uncover “informal groups that transcend the institutional boundaries” (Vogel, 2012, p. 1016) such as invisible colleges (Crane, 1972), and map research domains (Henry Small, 1973; Small, 2009).

When content analysis is performed within the citation context, researchers are able to explore the “intellectual lineage for a given idea” (Angrosh, Cranefield, & Stanger, 2011, p. 36), uncover the influence of concepts over time (Chang, 2013b; McCain & Salvucci, 2006), and provide citation classifications (Cronin, 1984). Over a 14 year period (1965 to 1979) 10 citation classification schemes were developed through content analysis, each with 4 to 29 categories to document citation motivation (Baldi, 1998). However, researchers have also developed classifications of how information contained in a cited article is incorporated into another through citation to reveal “how prior work shapes ongoing knowledge development” (Golden-Biddle, Locke, & Reay, 2006, p. 237).

Classification schemes are not mutually exclusive. For example, the appendix provided in Camacho-Minano and Nunez-Nickel (2009) review includes over 125 research studies providing citation function typologies and taxonomies. While the terms *typology* and *taxonomy* are often used interchangeably, “the basic difference is that a typology is conceptual while a taxonomy is empirical,” that is, the former is developed through qualitative analysis, while the latter is formed through quantitative analysis (Bailey, 1994, p. 6). A detailed description of typology and the protocols for typology development are provided in Chapter 3. While the purpose of this study is to trace theory symbol use over time by exploring the citation history of seminal publications and to provide a typology of theory symbol use in IDT academic publication, many of the citation function classifications included in Camacho-Minano and Nunez-Nickel (2009) are directly applicable and could not be ignored during the development of this review.

Moravcsik and Murugesan (Moravcsik & Murugesan, 1975; Murugesan & Moravcsik, 1978) performed the first comprehensive CCA in theoretical high energy physics to identify citation classifications for research evaluation (Bornmann & Daniel, 2008). Findings indicate that a researcher may critique a prior effort while at the same time incorporating some of its content. Also, a researcher may incorporate a portion of the prior effort while combining it with additional elements that may oppose the original approach (Moravcsik & Murugesan, 1975; Murugesan & Moravcsik, 1978). Mizruchi and Fein (1999) found that, of the citing articles studied, 72% briefly mentioned the cited article without further discussion, 12% discussed a concept from the cited article, and the remaining 16% tested at least one of the constructs. Similarly, Kacmar and Whitfield (2000) found that 92% of the analyzed citations incorporated prior work with negligible discussion, while the remaining 8% incorporated prior work as a key focus. Chubin and Moitra (1975) classified citations as either affirmative (4 types) or negational

(2 types) and found that the majority of cited full-length articles were affirmative but not directly connected to the content of the citing article. All three of these research efforts included a classification which relates to the acknowledgement of prior work without additional comment and demonstrate that prior research is incorporated through citation to varying levels of detail. These and similar studies have inspired researchers to explore citation contexts and the content that is transferred through citation in greater detail.

While researchers have traced citations made to articles about theory, these studies have focused on the citation counts and citation patterns across disciplines rather than on the content which is incorporated through citation. For example, Oehler (1990) traced citation patterns to articles about equilibrium theory, noting the citation counts in journals outside the social sciences and O'Rand (1992) examined the citation patterns of game theory across disciplines.

Exploring how earlier work is incorporated through citation may “advance understanding of how prior work is involved in ongoing knowledge development” (Golden-Biddle, Locke, & Reay, 2006, p. 239). As McCain (2011) explains, researchers may explore citations to a single publication or set of publications related to a subject, theory, research method, or concept and classify findings by topic and time. However, as McCain puts it, “studies of this kind . . . are rare” (McCain, 2011). A summary of recent CCA studies which include the extraction or classification of cited concepts (see Table 3).

Table 3

Recent Citation Context Analysis Studies which Include the Extraction or Classification of Cited Concepts

Researcher(s)	Subject	Period	Citation Contexts	Citing Articles
Anderson and Sun (2010)	Organizational Studies	1991–2006	496	301
M. Anderson (2006)	Organizational Studies	1969–2005	578	328
Chang (2013b)	Library science	1969–2010	347	273
Golden-Biddle et al. (2006)	Management	1989–1992	489	176
McCain and Salvucci (2006)	Software Project Management	1975–1999	574	497
Pooley (2015)	Sociology	1960–2011	not provided	265
Richardson and Pysek (2008)	Ecology	1960–2006	not provided	not provided
Sieweke (2014)	Organizational Studies	1980–2012	not provided	352

Pooley (2015) located citations to three publications by Paul Lazarsfeld and his team at the Bureau of Applied Research and examined them for their application of six key contributions. Findings from the review of 265 citing articles from 1975 to 1999 suggest that the works are most often cited through "mnemonic shorthands—pithy identifiers meant to activate researchers' shared memories" and are often cited similarly within certain research areas (p. 25). Rather than providing a typology of concept use, a summary of the individual concepts is provided. Similarly, Anderson and Sun (2010) explored the citation contexts for 578 references to Weick (1969, 1979) in 328 articles over the period 1969 to 2005 in order to identify concepts incorporated through citation. This approach is advanced in in which 496 citation contexts for Walsh and Ungson (1991) in 301 articles from 1991 to 2006 resulted in the classification of 12 concepts by discipline as well as the identification of claims that were made but not offered in the original work.

Other researchers provide additional detail by categorizing citations to concepts based on how they are used. For example, Mizruchi and Fein (1999) reviewed 160 citing publications and offered six categories ranging from the mention of a concept without providing an explicit reference on one extreme to operationalizing and testing the concept on the other. Chang (2013a) summarizes the cited concepts by the topic and disciplines of the resulting publications and classifies citations into 10 areas based upon citation use, including evidence, related literature, and methodology support among others.

Several researchers have compared the cited content to the original publication and not only developed a summary of key concepts but also of related multi-tiered classification systems. For example, McCain and Salvucci (2006) reviewed 574 citation contexts in 497 articles from 1975 to 1999 and provided a summary of cited content as well as classifications based on the level of detail included. Sieweke (2014) explored 352 articles which cite work published by Pierre Bourdieu and classified the cited concepts by the extensiveness of their use as limited, intermediate, or comprehensive. Similarly, Golden-Biddle et al. (2006) developed a typology through the content analysis of 489 contexts and 176 citing articles to three original publications. Seeking to capture the variety of citation practices, the researchers analyzed every citation for each of their identified cited articles. The resulting typology along with a summary of findings is provided (see Table 4). Levels 1, 2, and 3 refer to abstract theoretical claims, general claims, and detailed claims respectively. This coding system is similar to other efforts described in this review.

Table 4

Typology of Knowledge Used in Citing

Name	Description	Prevalence (%)
Central comprehensive	Citations carry forward all of the analytically general asserted knowledge claims. Materialization comprises at least Levels 1 and 2 of asserted knowledge claims. Direct material links to the cited article.	1.8
Central selective	Citations carry forward part of the asserted knowledge claims. Materialization comes from any level of the asserted knowledge claims. Direct material links to the cited article.	63.6
Peripheral	Citations carry forward knowledge content other than asserted knowledge claims. Materialization comes from knowledge content not stipulated as asserted knowledge claims. Direct material links to the cited article.	21.3
Restyling	Citations carry forward part of the asserted knowledge claims. Materialization comes from any level of the asserted knowledge claims. Indirect material links to the cited article from using different language.	8.0
Typification	Citations carry forward either part of the asserted knowledge claims or other knowledge content. Materialization comes from either asserted knowledge claims or other knowledge content. Indirect material links to the cited article from developing a general characterization.	5.3

Note: Adapted from Golden-Biddle, Locke and Reay (2006), p. 244

Related studies in IDT. A review of literature in IDT has not revealed any studies which explore the incorporation of theory or theory symbols into IDT academic publication. Instead bibliometrics have primarily been used to identify influential articles, authors, books, and journals in IDT. Content analysis of IDT scholarly publication has been historically performed in conjunction with bibliometrics and focused heavily on the citing article in isolation in order to identify research and publication trends. A summary of bibliometric studies in IDT (see Appendix A) demonstrates that the majority of, evaluative and relational work performed in IDT falls within the area of evaluative bibliometrics and that none of the studies include theory as an area of focus. The table includes the names of common citation context methodologies including co-citation analysis, bibliographic coupling, network analysis, and content analysis. Co-citation analysis refers to the linkage created when a pair of citations are included in the same article (H. Small, 1973), while bibliographic coupling describes the connection created when two documents incorporate one or more of the same citations (Kessler, 1963) (see Figure 4). Citation network analysis examines the structure and patterns of relationships among academic publications (Wasserman & Faust, 1994).

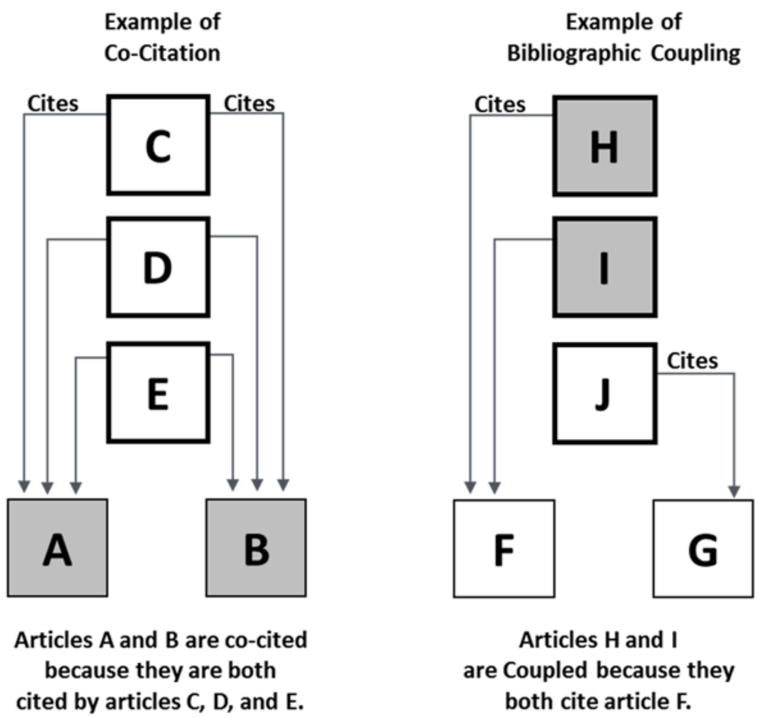

Figure 4. Co-citation and Bibliographic Coupling

Research Gap

This section introduced the conceptual framework that supports the development of a typology of theory symbol use in IDT academic publication, including discourse, theory and citation. Prior research revealed that while there is no shortage of discussion in IDT regarding the different types of theories (Reigeluth, 1983a, 1999, 2009; Richey et al., 2011), what functions they perform (Hoover & Donovan, 2011), and the application of theory by practicing instructional designers (Yanchar, South, Williams, Allen, & Wilson, 2010), there is a lack of research reporting how theoretical content is incorporated into IDT academic publication through citation. The call by editors and reviewers for more theoretically based publication is often met with a tidal wave of citations which merely include theory names, rather than content which "acknowledge[s] the stream of logic on which they are drawing and to which they are contributing" (Sutton & Staw, 1995, p. 372). As described earlier under Need for the Study, many researchers have called for a substantive study of citation and theory dissemination in order to address this gap between mere citation and actual engagement (Bort &Kieser, 2011; Martens, 2004; Pettigrew & McKechnie, 2001). This study aimed to take the first step in such an analysis by using CCA to trace theory symbol use over time, the result of which is a typology of theory symbol use which will allow researchers to better describe engagement with actual theories.

Chapter 3 - Methodology

The study employed citation context analysis (CCA) with a goal of developing a typology of theory symbol use in IDT academic publication. This chapter introduces the research processes so that readers may evaluate the approach and repeat the study. In Chapter 2, the researcher situated discourse, citation and theory within the larger system of IDT disciplinary knowledge and provided a review of related studies. The review revealed a lack of research of theory symbol use in IDT academic publication and resulted in three guiding questions as follows:

1. Which publications cited in ETRD qualify as *seminal*, that is, deemed to be foundational to a theory's creation or development over time?
2. What patterns of theory symbol use emerge when references in ETRD to seminal publications are traced over time?
3. How can emergent patterns support a typology of theory symbol use in IDT academic publication?

Research Study Design

The study employed a mixed method approach called CCA. CCA explores the relationships between cited and citing documents and the content which is transferred from one to the other through citation (Ritchie, 2008); it may be used to analyze cited concepts based on the text surrounding citations (Small, 1978). In this way, CCA is a combination of bibliometric analysis and content analysis.

Bibliometrics explores relationships between bibliographic elements contained in publication such as authors, journals, and articles (Havemann & Scharnhorst, 2010). Citations reflect the relationships between ideas (Borner, Boyack, Milojevic, & Morris, 2012) and "contain information about the dissemination of notions and theories" (Radicchi, Fortunato, & Vespignani, 2012, p. 248). Citation databases, such as those available through online libraries, "represent the starting point for any empirical study of the evolution and dynamics of scientific activity, citation patterns, and the ensuing analysis of the importance of specific contributions" (Radicchi et al., 2012, p. 233). In the study, bibliometric analysis is used to identify the relationships between cited and citing documents in order to identify the sample to be explored through content analysis.

Content analysis is "a research method that uses a set of procedures to make valid inferences from text" (Weber, 1990, p. 9) for the purpose of creating "a numerically based summary of a chosen message set" (Neuendorf, 2002, p. 14). Through the analysis of citation-related text, researchers can uncover content which is transferred during the citation process (M. Anderson, 2006; Golden-Biddle et al., 2006; Lounsbury & Carberry, 2005; Mizruchi & Fein, 1999), document the influence of theory (Lounsbury & Carberry, 2005), and identify knowledge claims (M. Anderson, 2006). In the study, content analysis is used to explore the content which is transferred from cited to citing documents.

Taken together, bibliometric analysis and content analysis provide an integrative framework for CCA and support development of a typology of theory symbol use in IDT academic publication. The methodology is comprised of the following seven steps adapted from Neuendorf (2002):

1. Theory and rationale
2. Conceptualization and Coding Scheme
3. Operationalization
4. Sampling procedures
5. Codebook
6. Coding procedures
7. Analyze and report results

Step 1: Theory and Rationale

In Step 1, Theory and Rationale, the research focus, framework and rationale were identified (Neuendorf, 2002). These areas relate to the problem statement, research questions, framework and significance of the study provided in Chapter 1 and Chapter 2. During this step the researcher also identified the content to be examined (Neuendorf, 2002). For the study this relates to the selection of the theories of focus and journal of focus.

Theories of focus. Following Golden-Biddle et al. (2006), the typology of theory symbol use was developed through the exploration of a variety citation contexts in journal articles that represent a range of uses including articles using quantitative and qualitative methods in both empirical and theoretical articles. Given the breadth of application for the study within the context of IDT, the following criteria provided by Weibell (2011) were used to select the theory of focus (p.11):

1. Clarity – the theory is clear and precise and may be distinguished from other theories.
2. Stability – the theory is well developed and the related ideas are relatively stable.
3. Utility – the theory provides insight into learning processes and considered practical for application.
4. Impact – the theory has attracted attention from people outside of those directly influenced by the original researcher.
5. Durability – the theory has been applied and formally studied for several years.

In this study, the researcher explored cognitivism, a theory noted by Weibell (2011) as meeting the noted criteria are selected for the study. According to Alessi and Trollip (2001), the "current world of educational theories is really a triangle, with behaviorism, cognitivism, and constructivism at the vertices" (p. 38). Ertmer and Newby (2013) explain that these three approaches are "distinctive enough to be treated as separate approaches to understanding and describing learning" and have both historical and current relevance in the field (p. 46).

Journal of focus. As described in Chapter 2, academic writing constitutes "an engagement in a social process, where the production of texts reflects the methodologies, arguments, and rhetorical strategies constructed to engage colleagues and persuade them of the claims made" (Hyland, 2005, p. 66). Researchers build arguments through writing and "project themselves into their discourse to signal their attempts, commitments, and attitudes" in an effort to have their work incorporated into the disciplinary consensus (Abdi, Rizi, & Tavakoli, 2010; Hewlings, 2006, p. 1670). In this way, disciplinary norms are revealed at the text dimension of discourse. Citation conventions, argument structure, as well as approaches for describing established disciplinary knowledge vary by discipline (Becher, 1987). To control for the potential variation in theory symbol use that may occur across disciplines when an article is incorporated into another through citation, a single journal from a single discipline was selected for this study.

ETRD was selected as the journal of focus for reasons provided by Driscoll and Dick (1999). First, it is a central journal for the Association for Educational Communications and Technology (AECT), one of the largest professional organizations in IDT. And second, the journal focuses on both research and development and will likely "provide a representative picture of the types of research being conducted in the field today" (Driscoll & Dick, 1999, p. 10).

Educational Technology Research and Development (ETRD) was formed through the merger of Educational Communication and Technology Journal (ECTJ) and the Journal of Instructional Development (JID) (Sullivan & Higgins, 1989). ECTJ was also published under the title, Audio-Visual Communication Review (AVCR) which was later called AV Communication Review (Saettler, 2004). JID was designed to serve the instructional developer practitioners with articles related to the performance, management and teaching of instructional development processes with the goal of providing articles which "improve the skills of instructional developers" (Silber, 1977, p. 2).

Springer provides access to all issues of ETRD and its predecessor journals, with the exception of JID, under the ETRD title. As discussed in Step Five, Sampling Procedure, the bibliometric analysis includes all issues of ETRD and its predecessor journals, except JID.

Step 2: Conceptualization and Coding Scheme

In Step 2, Conceptualization and Coding Scheme, the variables were defined and the coding scheme was created (Neuendorf, 2002). In the study, variables were selected through a literature review. A variable is described as a "definable and measurable construct that varies, that is, it holds different values for different individual cases or units" (Neuendorf, 2002, p. 48). The definitions of the variables are up the discretion of the researcher, "there is no one right way" (Neuendorf, 2002, p. 50). Similarly, the context in which the variable appears is "the analyst's choice within which to make sense of a body of text" (Krippendorff, 2013, p. 30) (p. 30).

Variables may be categorized as either latent or manifest. Manifest content is "physically present and countable" (Gray & Densten, 1998, p. 420), such as the keywords in a journal article, or the number of citations included in a single sentence. In contrast, latent content "cannot be measured directly, but can be represented or measured by one or more…indicators" (Hair, Anderson, Tatham, & Black, 1998, p. 581), such as the manner in which a citing article incorporates information from a cited article through citation. Manifest and latent variables were selected for the study (see Table 5). To support application across disciplines, Szostak (2008) recommends that classifications are developed to be ordered, exclusive and monothetic. Ordered refers to the classification of theory "in terms of a handful of key characteristics" (p. 323). Exclusive refers to the degree of precision, with the goal of limiting the overlap among categories. The final area, monothetic, calls for phenomena to be classified according to their "essence or function" (Szostak, 2008, p. 323). The researcher created the list of typology categories (see Table 5) with these recommendations in mind.

Table 5
Manifest and Latent Variables/Typology Categories

Type	Type	Variable/Typology Categories	Description
Manifest	1	Theory symbol age	The difference between the publication year of the citing article and the cited seminal article.
	2	Author and writer relation	Indicates if any of the publication author(s) names are also the name(s) of the citing article writer(s).
	3	Citing article topic	The topic of the citing article.
	4	Multiplicity	Number of times the selected seminal article is cited in the given article divided by the number of published pages in the citing article.
	5	Location of citation	Section in which the theory symbol is incorporated into the citing article.
	6	Citation clustering	The number of citations included in with the theory symbol citation within the same sentence.
	7	Citation integration	The integration of the citation as being explicit or implicit.
	8	Citation style	The style of theory symbol citation such as a summary or quotation.
Latent	9	Theory symbol materialization	The manner in which the citing article incorporates information from the seminal article through citation.

The remainder of this section provides a description of each of the manifest and latent variables as well as the codes assigned to each. "A code in a qualitative inquiry is most often a word or short phrase that symbolically assigns a summative, salient, essence-capturing…attribute for a portion of language-based or visual data" (Saldana, 2013, p. 3).

The variables were identified through a review of literature related to discourse, citation and theory as well as prior theory context and citation context research studies. Recall that these variables become the categories of the typology of theory symbol use in IDT academic publication.

Variable/Typology Category 1: Theory symbol age. This variable was calculated as the difference between the publication years of the citing article and the cited seminal article. Changes in citation patterns over time can indicate "its perceived rhetorical usefulness by later scholars…the use of reasonably highly cited documents can show different general patterns when viewed over 10+ years" (McCain, 2011, p. 1412).

Variable/Typology Category 2: Author and writer relation. The purpose of this variable was to record if any of the publication author(s) names were also the name(s) of the citing article writer(s). Two categories provided by Zhang, Ding, and Milojević (2013) support this variable: reciprocal (self-citation in that the author(s) of the seminal publication match the writer(s) of the citing article), parallel (a co-writer from citing article matches an author of the seminal article). The third category called hierarchical used to indicate a citation is related to an author with "high social capital" (p. 1498) is not applicable to this study. Instead, a third category titled *unrelated* was created to indicate that the author(s) of the seminal publication do not match the writer(s) of the citing article). A common assumption about citation is that self-citations should not be included in analysis because they "are likely to be self-serving and self-indulgent" (Swales, 2004, p. 84). Following Golden-Biddle et al. (2006), the study includes all citations, including self-citations, in order to reflect the breadth of theory symbol use.

Variable/Typology Category 3: Citing article topic. The topic of the citing article was recorded as Variable 3. Sarafoglou and Paelink (2007) used citation data to a key book called

"Spatial Econometrics: Methods and Models" to explore the use of the concept "spatial econometrics" across time and subjects. Similarly, Garfield (1985) studied citations to a Price's (1965) publication, across disciplines and areas of specialty. Related to theory, Martens (2004) performs a CCA to explore the use of eight theories in the social sciences but does not include the subject as a variable. However, none of these studies consider the content that is transferred from one publication to another through citation. Following Chicksand, Watson, Walker, Radnor, and Johnston (2012) and Pettigrew and McKechnie (2001), the topic was identified by the first keyword if provided. If keywords are not available, the abstract and introduction will be reviewed to identify the topic.

Variable/Typology Category 4: Multiplicity. This variable captured the result of calculating the number of citations per published pages in the citing article. The frequency of citations a single publication receives in a single article can indicate its significance (Zhang et al., 2013). As Herlach (1978) argues, a publication cited in the introduction or literature review and cited again in other sections, such as methodology or discussion, has a greater impact on a citing article than a publication that was cited once. As summarized by Zhang et al. (2013), "it is possible that a reference that was mentioned more than five times in different sections of an article is more important than a reference that was only mentioned once at the very end" (p. 1497). Following guidance from Johnston, Piatti, and Torgler (2013), "citations per published page" rather than the total number of citations (p. 1026) was recorded for this variable. They note that this approach controls for differences in the number of pages in the articles between the paper types, noting that "empirical papers are longer on average than theoretical papers" (p.1026).

Variable/Typology Category 5: Location of citation. This variable refers to the section in which the theory symbol is incorporated into the citing article. Following Zhang et al. (2013), seven codes were applied: abstract, introduction, literature review, methodology, results/discussion, conclusion and others as specified.

Variable/Typology Category 6: Citation clustering. This variable relates to the number of citations included in with the theory symbol citation within the same sentence. Three codes provided by Chang (2008) are applied as follows: none (additional citations are not included in the same sentence as the citation of focus), small cluster (there are one or two additional citations in the same sentence in addition to the citation of focus), and large cluster (there are three or more additional citations in the same sentence in addition to the citation of focus).

Variable/Typology Category 7: Citation integration. This variable indicates if the citation was either explicitly or implicitly integrated. These terms are used by Jaidka, Khoo, and Na (2013) and who describe explicit citations as those which introduce the work of others by including the author(s) name in the cited text and an implicit citations which include the author(s) names at the end of a sentence in parenthesis. There are many examples of researchers applying similar frameworks. For example Swales (1990) is cited as providing the most frequently cited description (Petrić, 2007) for integral and non-integral citations. As Swales (1990) explains, integral citations include the name of the cited author's name within the cited text, while non-integral citations include the author's name outside of the text such as in parenthesis at the end of a sentence, or in footnotes. Other researchers have extended this typology by offering sub-categories. For example, Thompson (2001) applies linguistic analysis and divides integral citations based on the inclusion of a controlling verb, or whether the citation is part of a noun phrase. A weakness of the use of the terms integral and non-integral is that they may infer citation function. This study focuses on the context and content of the citation rather rhetorical functions or citer motivations. As a result, terms as applied by Jaidka et al. (2013) are used as codes in the study.

Variable/Typology Category 8: Citation style. The citation style indicates if the citation was a summary or quotation of prior work. According to Hyland (2004), the majority of citations are presented as summaries of prior work. The categories included for this study include summary (no quotation was included), short quote (the quotation was contained within a single sentence), long quote (the quotation covered two or more sentences).

Variable/Typology Category 9: Theory symbol materialization. The manner in which the citing article incorporates information from the seminal article through citation was captured in this final variable. Whereas Variable 1 through Variable 9 are all related to characteristics of citation contexts, only Variable 9, Theory Symbol Materialization, considers the content transferred from the cited to citing article through citation. Variable 9 was the primary variable for the study, and the only latent variable. This variable related to the concept of intertextuality (Fairclough, 2003). *Intertextuality* refers to how a text incorporates elements from other texts, an example of which is citation (Bazerman, 1988). This process is also referred to as *recontextualization*. When prior work is recontextualized, decisions are made about what to incorporate and what to leave behind. Combining these works influences change in other discourses as well as the social world (Fairclough, 2003). Researchers do not “typically make large leaps in their research, they tend to . . . [work] outward from the edges of their settled knowledge. Hence, we usually have a complex chain or network of related discoveries that amount (in effect) to a larger discovery” (Gerson, 2002, p. 281).

As discussed in Chapter 2, few studies have explored citations to characterize the content transferred from prior work. Categorizations from recent CCA studies which include the extraction or classification of cited concepts (see Table 6).

Table 6
Categorizations from Recent CCA Studies Which Include the Extraction or Classification of Cited Concepts

Researcher(s)	Classification Description
Anderson and Sun (2010)	Inclusion of key concepts provided in cited article and identification of claims not actually made in cited article.
M. Anderson (2006)	Identification of concepts incorporated through citation.
Chang (2013b)	Citing article topics and discipline. Cited concepts and citation functions (related literature, evidence, views, terms, background, relationship, definitions, comparison, further reading, and methods). Cited concepts by function was also provided.
Golden-Biddle et al. (2006)	Classification of cited content (central comprehensive, central selective, peripheral, restyling, typification) (p. 244).
McCain and Salvucci (2006)	Multi-layered classification system related to the cited content from general concepts to categories of areas of focus related to the original book and specific concepts included.
Pooley (2015)	Use of key concepts from the three publications as well as the inclusion of historical context.
Richardson and Pysek (2008)	Identification of concepts incorporated through citation.
Sieweke (2014)	Use of key concepts provided in Bourdieu's work, and three classifications related to the extensiveness of the usage (limited, intermediate, comprehensive).

While all of the recent CCA studies noted above explore the content that is incorporated through citation, all examples except Golden-Biddle et al. (2006) and Anderson and Sun (2010) develop the classifications based on a review of the concepts incorporated through citation. In contrast, Golden-Biddle et al. (2006) and Anderson and Sun (2010) identify the knowledge claims made in the cited article and compare it to the information transferred to the citing article through citation. In doing so, these two research teams are able to identify information that is transferred as well as information that is not transferred. Of these two studies, Golden-Biddle et al. (2006) offers a more detailed methodology which supports the comparison of results across publications.

The final typology resulting from Golden-Biddle et al. (2006) served as the basis for the codes used for Variable 9, Theory Symbol Materialization. The original typology from Golden-Biddle et al. (2006), is provided in Chapter 2 (see Table 4).

Three levels of knowledge claims are developed for each seminal article selected for the study, including Level 1 (abstract theoretical), Level 2 (general argument or findings) and Level 3 (detailed argument or findings) (Golden-Biddle et al., 2006). Note that the process to select the seminal publications is provided in Step 5, Sampling Procedures. The codes were modified during the pilot study and modifications were incorporated into the theory symbol materialization (see Table 7).

Table 7

Codes for Variable 9, Theory Symbol Materialization

Name	Description
Comprehensive	Citation carries forward the following from the seminal article to the citing article: • All Level 1 (abstract theoretical) knowledge claims • All Level 2 (general argument or findings) knowledge claims • Any Level 3 (detailed argument or findings) knowledge claims may also be included • Any knowledge claims not included as Level 1, 2 or 3 may also be included
Selective	Citation carries forward **any of** the following from the seminal article to the citing article: • Any Level 1 (abstract theoretical) knowledge claims, **and/or** • Any Level 2 (general argument or findings) knowledge, **and/or** • Any Level 3 (detailed argument or findings) knowledge claims • **Additionally,** any knowledge claims not included as Level 1, 2 or 3 may be included
Peripheral	Citation carries forward the following from the seminal article to the citing article: • None of the Level 1 (abstract theoretical) knowledge claims • None of the Level 2 (general argument or findings) knowledge claims • None of the Level 3 (detailed argument or findings) knowledge claims • Any knowledge claims not included as Level 1, 2 or 3
Typification	Citation carries forward **any of** the following from the seminal article to the citing article: • Any Level 1 (abstract theoretical) knowledge claims restated as a general characterization • Any Level 2 (general argument or findings) knowledge restated as a general characterization • Any Level 3 (detailed argument or findings) knowledge claims restated as a general characterization

Note: Revised text is bold and underlined. Adapted from Golden-Biddle, Locke and Reay (2006), p. 244.

The three levels were developed through what Golden-Biddle et al. (2006) describes as an "inductive theory-building approach" (p. 240). This approach aligns with Krippendorff (2013) description of inductive inferences from content analysis which begins with details and ends with generalizations. This process began by carefully reading each seminal article and creating lists of knowledge claims provided in the text (Golden-Biddle et al., 2006). Each seminal article is read multiple times. The first reading is for general understanding. During the second reading, the researcher highlighted the detailed knowledge claims and note any generalizations provided by the author. During the third reading, the researcher categorized knowledge claims into each of the three levels. The first level is the most general, the second includes more specific claims about the argument or findings, and the third level contains the most detailed knowledge claims. Heeding guidance from McCain and Salvucci (2006), when identifying and summarizing the knowledge claims into the three levels an attempt is made to “strike a balance between: 1) establishing separate categories for infrequently encountered ideas, and 2) showing shifts of interest, over time and subject area” (p. 281).

Step 3: Operationalization

In Step 3, Operationalization, the units to be collected were identified (Neuendorf, 2002). A unit is defined as “an identifiable message or message component” (Neuendorf, 2002, p. 71). Extending Bacharach (1989) description of theory as “a statement of relations among concepts” (p. 496), Bort and Kieser (2011) explain that concepts can be applicable in different contexts. The analysis of content contained within citation contexts is noted as an effective methodology for exploring the impact of highly cited publications (White, 2004). Following Golden-Biddle et al. (2006), the goal was to select a variety of citation contexts in ETRD that represent a range of uses, including articles employing quantitative and qualitative methods in both empirical and theoretical articles. Golden-Biddle et al. (2006), Anderson and Sun (2010), M. Anderson (2006), McCain and Salvucci (2006) and Sieweke (2014) analyze all citation contexts related to their identified areas of focus.

An individual citation context may include a few words before and after a reference, multi-sentence passages, sections and paragraphs where the citation is located (Angrosh, Cranefield, & Stanger, 2013; Eto, 2013; Herlach, 1978; Paul, 2000). The study explored the entire text passage developed to transfer information from the original publication through citation in ETRD, whether that be a sentence or entire paragraph.

Step 4: Sampling Procedures

In Step 4, Sampling Procedures for identifying the seminal article and citation context samples were identified (Neuendorf, 2002).

Seminal article sample. Identifying the seminal article sample was a multistep process. First, publications which qualify as seminal, that is, deemed to be foundational to the creation or development of cognitivism were identified. Recall that in Step 1, Theory and Rationale, these were identified as the theory of focus. Note that an attempt was not made to identify seminal publications related to finer delineations of the theory, such as cognitive load. The second step was to identify which of the seminal publications were cited in ETRD. This step answers Research Question 1: Which publications cited in ETRD qualify as seminal, that is, deemed to be foundational to a theory's creation or development over time? The third step was to select a sample of the seminal publications cited in ETRD to be analyzed in the study.

Step 1: Identify seminal publications. The first step was to identify seminal publications related to cognitivism. Theories and corresponding historic texts may be located by searching for related terms. For example, Weerakkody, Dwivedi, and Irani (2009) performed a search for the term institutional theory to identify related articles. Similarly, Williams (2012) performed a search for the terms "instructional design theory," "instructional design models," and "instructional design theories," to identify instructional design theories used in the discipline of IDT (p. 13). J. Anderson (1996) and Chung, Barnett, Kim, and Lackaff (2013) used theory names and synonyms to locate material of interest. Finally, Bort and Kieser (2011) performed a review of discipline specific literature, including handbooks, to identify influential publications specifically related to organizational theory.

Using books to identify seminal publications. Following Bort and Kieser (2011), a review of discipline specific literature, including books, discipline specific handbooks, and journal articles was performed. The first step in this process was to identify all books cited in ETRD from 1953 to 2012. The traditional method for identifying publications cited in a journal is to download citations from the ISI Web of Knowledge by Thomas Reuters (Johnston et al., 2013). However, this service does not provide citations prior to 1974. Following Angrosh (2012), citations for ETRD from 1953 to 2012 were obtained through a process called web scraping/web content mining in which content is extracted from an online source and stored in a database.

As Ambika and Latha (2014) describes, web content mining extracts text, images or other records from a webpage. There are a number of tools for mining web content, a few include: Automation anywhere, Mozenda, Web information Extractor, Web content Extractor, and WebMiner (Ambika & Latha, 2014). Researchers describe Mozenda as a user friendly platform (Bharanipriya & Prasad, 2011; Kumar, Arthanari, & Shanthi, 2014). Citations and article details from ETRD (1953 to 2012) were exported from Mozenda to MS Excel. As Cobo, López-Herrera, Herrera-Viedma, and Herrera (2011) explain, downloaded bibliometric data often contains duplicate data and misspellings. Following their guidance, duplications were deleted.

After all cited books were identified, a search was performed to identify books in which the reference of each book included the terms “theory,” “theories,” “cognitive,” “cognition” or “cognitivism”. The seminal publications which were each cited 10 or more times in the original sample comprised of books, handbooks and ETRD journal articles and also cited 10 or more times in ETRD over the 60-year period were selected for analysis. These books were then obtained from the Virginia Tech library or online sources.

Book indexes were used to identify pages related to the theories of focus. The identified pages from the chapters, references and indexes were reviewed, scanned via the Evernote Scanner app and uploaded to Evernote and Dropbox. Section headers serve as a useful guide during this process. Discipline specific handbooks, including the four editions of the Handbook of Research for Educational Communications and Technology, were downloaded from the AECT website. The indexes provided in the back of each handbook are used to identify pages related to the theories of focus. The identified pages were reviewed with section headers serving as a guide. Each applicable citation was located in the reference list and the entire record was captured via the Comment function in Adobe Acrobat Professional.

Using articles in ETRD to identify seminal publications. A search for the terms "theory," "theories," "cognitive," "cognition" or "cognitivism" was performed within the title field for all ETRD articles published between 1953 and 2012. The identified pages were reviewed. Section headers served as a guide. Each applicable citation was located in the reference list and the entire record was documented captured via the Comment function in Adobe Acrobat Professional.

Results from all three approaches wereaggregated into a single list of seminal publications by exporting the comments from Adobe, performing a process to eliminate extraneous style markers in MS Word, such as carriage returns, and copying the resulting datasets into MS Excel.

Step 2: Identify the seminal publications cited in ETRD. Recall that in Step 1, all citations from ETRD from 1953 to 2012 were obtained through web scraping and organized in

MS Excel. As a final step, this list of citations was compared to the list of seminal publications resulting from Step 1 in order to identify the seminal publications cited in ETRD.

Step 3: Select a sample of seminal publications cited in ETRD. As a final step, a sample of seminal publications cited in ETRD were selected. This sample included the five most frequently cited articles related to cognitivism as revealed by both their frequency in the original sources as well as within the ETRD articles over the 60-year period.

Citation context sample. Following Golden-Biddle et al. (2006), the study explored every instance that the sample seminal publications are cited in ETRD from 1953 to 2012. As described in Step 5, Sampling, MS Excel was used to store references included at the end of all articles, abstracts, biographical summaries, book reviews, and editorials published in ETRD from 1953 to 2012. Through an iterative process, the articles in which the seminal publications were also included in the reference lists were identified. The PDF files of the identified articles were downloaded from the library and organized into portfolios within Adobe Acrobat Professional. Details about the articles were logged in Excel for identification (see Table 8).

Table 8

Citation Details Logged During Coding

Number	Variable	Description
1	Seminal publication title	The title of the seminal publication to delineate specific publications from one another
2	Seminal publication author(s)	The full name(s) of the seminal publication author(s) to provide further identification.
3	Seminal article publication year	The year the seminal article was published.
4	Seminal publication series title	The title of the seminal publication journal or book as applicable to provide specification.
5	Seminal publication theory	The theory related to the seminal publication (cognitivism).
6	Citing article title	The title of the citing article to delineate specific publications from one another.
7	Citing article writer(s)	The full name(s) of the citing article writer(s) to provide further identification.
8	Citing article publication year	The year the citing article was published.

Step 5: Codebook

In Step 5, the codebook was created (Neuendorf, 2002). The codebook was created with the variables and codes described in Step 2, Conceptualization and Coding Scheme and modified during the pilot study (see Table 9). The final codebook is provided.

Table 9

Codebook for CCA

Variable Type	Number	Variable	Code
Manifest	1	Theory symbol age	(specify)
	2	Author and Writer relation	1. Reciprocal (self-citation of author(s)) 2. Parallel (co-writer from citing article is an author of the seminal article) 3. Unrelated
	3	Citing article topic	(specify)
	4	Multiplicity	1. Single (once) 2. Multiple (2 to 3) 3. Repeated (4 times or more)
	5	Location of citation	1. Abstract 2. Introduction 3. Literature review**/Framework** 4. Methodology 5. Results/Discussion**/Future Research** 6. Conclusion 7. Other (specify)
	6	Citation clustering	1. None (no additional citations) 2. Small cluster (1 to 2 additional citations) 3. Large cluster (3 or more additional citations)
	7	Citation integration	1. Explicit (name in sentence) 2. Implicit (name in **table,** parenthesis or footnote)
	8	Citation style	1. Summary 2. Short quote (contained in a single sentence) 3. Long quote (two or more sentences)
Latent	9	Theory symbol materialization	1. Comprehensive 2. Selective 3. Peripheral 4. Typification

Note: Revised text is bold and underlined

Step 6: Coding Procedures

In Step 6, Coding Procedures were defined (Neuendorf, 2002). As recommended by Chelimsky (1989), the researcher originally created the codes to be: 1) exhaustive so that the details relevant for the study could be categorized, 2) mutually exclusive so that each coded item related to no more than one category, and 3) independent so the assignment of a code for a unit would not be affected by codes assigned to other units. To check that these conditions had been met, a pilot study was performed. During the pilot study, the researcher coded a random of sample of 10% of the citation contexts related to a single, randomly selected seminal publication. The random sample of both the citation contexts and seminal publication was identified using the random function in MS Excel. The same sample was recoded 10 days later (Schreier, 2012). The results were logged in MS Excel. The two rounds of coding were be compared for consistency and the codebook was adjusted (Schreier, 2012). While the researcher did not encounter challenges completing the pilot study sample coding, the process uncovered potential difficulties given other scenarios. The revisions for Variable 9, Theory Symbol Materialization (see Table 7), included adding clarifying words to the Selective and Typification Codes that were assumed but proved confusing when omitted. The codebook (see Table 9) was modified to reflect changes to the variables titled Location of Citation (Code 5) and Citation Integration (Code 7).

Schreier (2012) argues that when codes are used to describe material "one might even say that it is better to try out your coding frame on part of the very material on which you will carry out the main coding" (p. 148). Following this guidance, the sample citation contexts from the pilot study were included in the main coding for the research study. Following the pilot study, coding began with the seminal article which had the earliest publication date. All citation contexts were coded starting with the earliest citation date and continued longitudinally until all citation contexts for the seminal article were coded. The researcher moved forward in time until all citation contexts related to the remaining seminal publications were coded. This process was intended to allow the researcher to recognize trends that may not have been uncovered during final analysis.

Reliability. After all citation contexts related to each seminal article were coded, a reliability test was performed. Reliability is defined as “the extent to which a measuring procedure yields the same results on repeated trials” (Neuendorf, 2002, p. 112). During the test, the researcher recoded a random sample of 10% of the citation contexts across seminal publications. In other words, the sample resulted in the recoding of citation contexts related to a variety of seminal publications. The intra-coder agreement rate was be calculated for each variable (Sieweke, 2014) as provided by Schreier (2012), with results provided in Chapter 5:

$$\text{Percentage of agreement} = \frac{\text{Number of units of coding on which the codes agree}}{\text{Total number of units of coding}} \text{ x } 100$$

Validity. A codebook is considered “valid to the extent that the categories adequately represent the concepts under study” (Schreier, 2012, p. 175). The study includes both manifest and latent variables. Manifest variables are more standardized and easier to understand by different people, while latent variables may carry multiple meanings (Schreier, 2012). The latent variable for the study is called theory symbol materialization.

Face validity and content validity are the most important types of validity for research studies which focus on the description of material rather than on making inferences that extend beyond the material (Schreier, 2012). Face validity is the is the extent to which the coding scheme appears to measure what is intended, it is also referred to as the “what you see is what you get” validity (Neuendorf, 2002, p. 115) and is primarily a concern for studies which use an inductive approach for developing codes (Schreier, 2012). Content validity measures the degree that a coding scheme covers all the dimensions of a variable and is most applicable for studies using a deductive approach for developing codes Schreier (2012). Recall from Step 2, Conceptualization and Coding Scheme, that the codes for the latent variable for the study were developed through an inductive approach which begins with the details and ends with generalizations. As a result, face validity is of primary concern. To improve face validity, the researcher provides detailed specifications for applying each code for the latent variable. For example, instructions for coding the use of Level 1, 2 or 3 level content is provided. In addition, a summary document was created for each seminal article which defined the content included in each of the three levels for easy reference.

Step 7: Analyze and Report Results

The results are analyzed in response to the research questions (Neuendorf, 2002). To establish quality and rigor, the researcher employed a codebook, pilot study, and reliability test. An outline of research questions, data analysis methods and outcomes is provided (see Table 10).

Table 10

Outline of Research Questions, Data Analysis Methods and Outcomes

Research Question	Data Analysis Methods	Outcomes
Which publications cited in ETRD qualify as *seminal*, that is, deemed to be foundational to a theory's creation or development over time?	Citation analysis	List of seminal publications cited in ETRD related to cognitivism
What patterns of theory symbol use emerge when references in ETRD to seminal publications are traced over time?	Citation analysis	Citation analysis of the results of the sampling procedures
How can emergent patterns support a typology of theory symbol use in IDT academic publication?	Content analysis	Coded variables for the sample citation contexts and a summary, formatted as categories in a final typology of theory symbol use

Summary

This chapter outlined the methodology for developing a typology of theory symbol use in IDT academic publication. With support from Klein (1990) and Salter and Hearn (1996), Szostak (2008) argues that theory is one of the important elements of academic research which could benefit from classification because it is a "key identifying characteristic of disciplines, and thus [a] key [element] that interdisciplinary scholarship must integrate across" (p. 321). While this study focused on IDT academic publication, the researcher performed a review of literature to identify variables/typology categories that "facilitate interdisciplinary inquiry" and increase the potential application of the typology (Szostak, 2008, p. 329).

Chapter 4 - Findings

Chapter 4 presents the results of the study including a summary of the data collected and findings of that data. The guiding research questions serve as a framework for the discussion. Due to the numerous steps required to identify the study sample for coding, figures which include the steps and related findings are included at the beginning of each section.

RQ1: Which publications cited in ETRD qualify as seminal, that is, deemed to be foundational to a theory's creation or development over time?

The response to Research Question 1 was obtained through the sampling procedures provided in Chapter 3, Methodology. An alignment of the sampling procedures to the research findings is provided (Figure 5). Additional figures related to the individual steps are provided in the pages to follow.

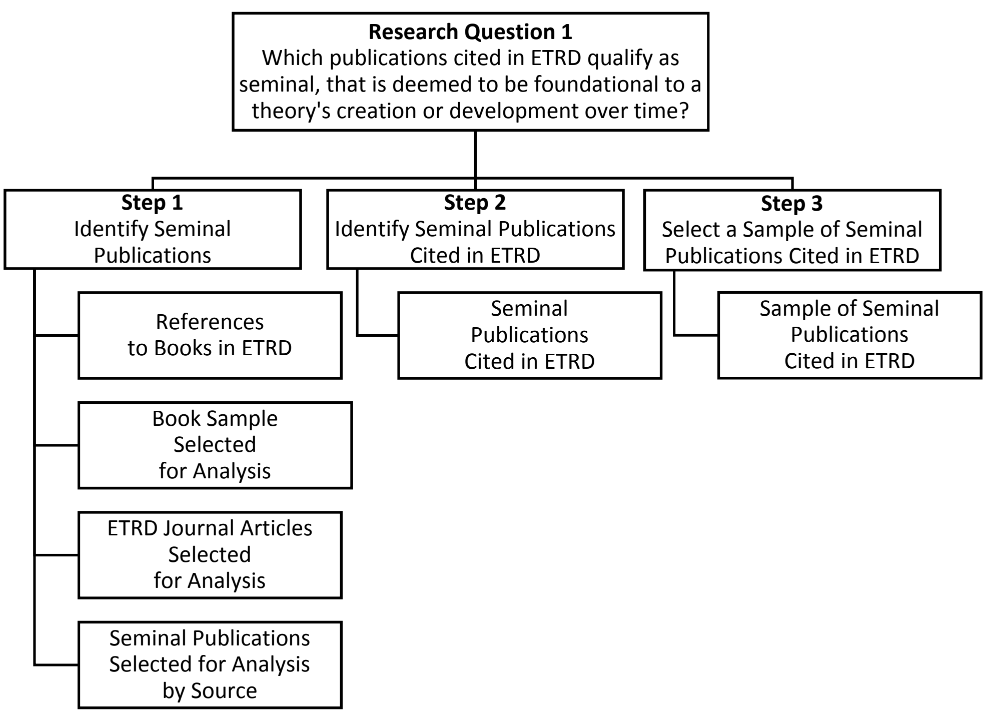

Figure 5. Research Question 1 Overview

Step 1: Identify Seminal Publications

References in ETRD to Books from 1953 to 2012. Following Angrosh (2012), article details and references included in ETRD from 1953 to 2012 were obtained through a process called web scraping/web content mining. This resulted in a dataset comprised of 60 volumes, including 260 issues and 2,607 articles. Reconciling the dataset to volume, issue and reference details provided on the website revealed two missing issues (Volume 56, Issues 5 and 6) and related references. This data was included on a website subpage that was not included in the web scraping script. Article details and references from these issues were copied from the website, pasted into the dataset and reconciled successfully. The majority (65.6%) of the articles over the 60-year period contained references, resulting in a dataset of 1,716 articles and 49,575 related references. An overview of the related sampling procedures to the research findings is provided (see Figure 6).

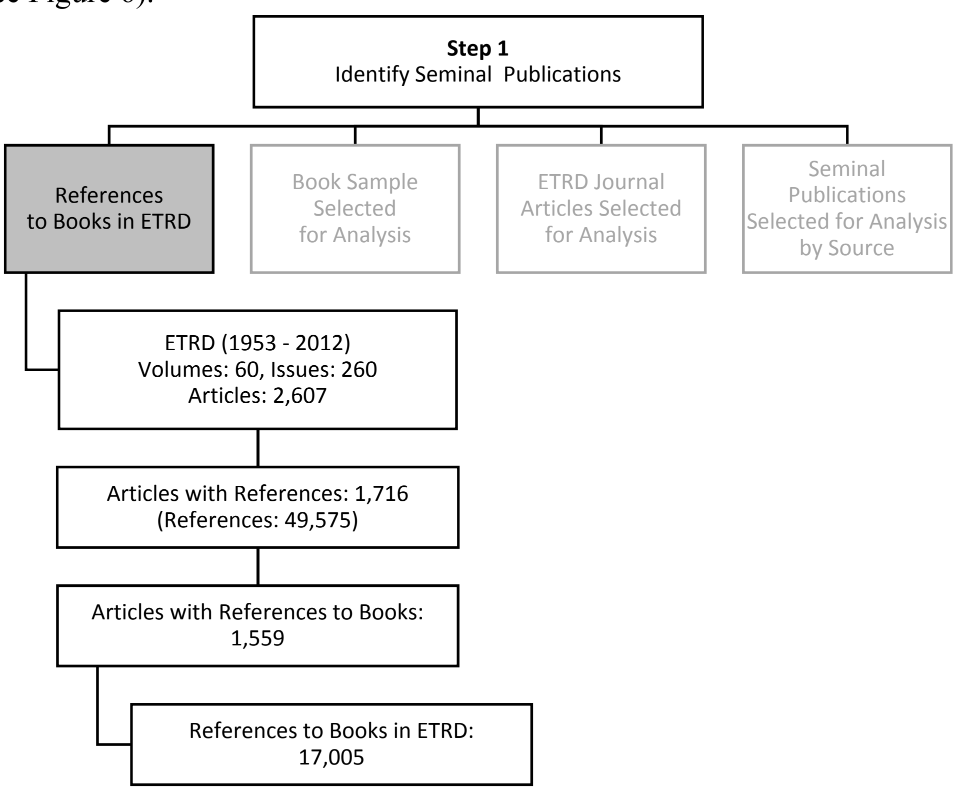

Figure 6. Overview of References to Books in ETRD

The reference list was reviewed to identify references to books. The researcher reviewed each row of data with the assistance of formulas able to identify words commonly associated with certain types of references such as conference proceedings, journals and books. For example, the term, “proceedings” aids in identifying potential conference publications, common journal names are helpful in identifying identify potential references to journals, and publishing company names helped to identify potential books. After flagging the references with formulas, the researcher reviewed the data and made corrections through an iterative process. The 49,575 reference dataset contained 17,005 (34.3%) references to books within 1,559 (90.9%) of the 1,716 articles. This indicated that while the majority of references were to sources other than books, books were included in the majority (90.9%) of the articles containing references over the 60-year period. Note that references in ETRD to books does not equate to the number of unique book titles.

Book sample selected for analysis. Following Weerakkody, et al. (2009) and Williams (2012) who used key terms to identify relevant sources, references to books containing a publication year in addition to the term cognitive, cognitivism, cognition, theory, and/or theories were extracted. This dataset contained 2,481 references, equating to 14.6% of the 17,005 references to books, and 5.0% of the 49,575 references cited in ETRD over the 60-year period. An overview of the related sampling procedures to the research findings is provided (see Figure 7). The reference formatting varied greatly across the dataset and may have resulted in applicable references being disqualified from the dataset in error. For example, some references included book subtitles and chapter names while others did not and it is possible that the missing data may have contained one of the key terms noted above. As a result, the 2,481 references to books were processed by hand in order for the frequency for each book title to be calculated.

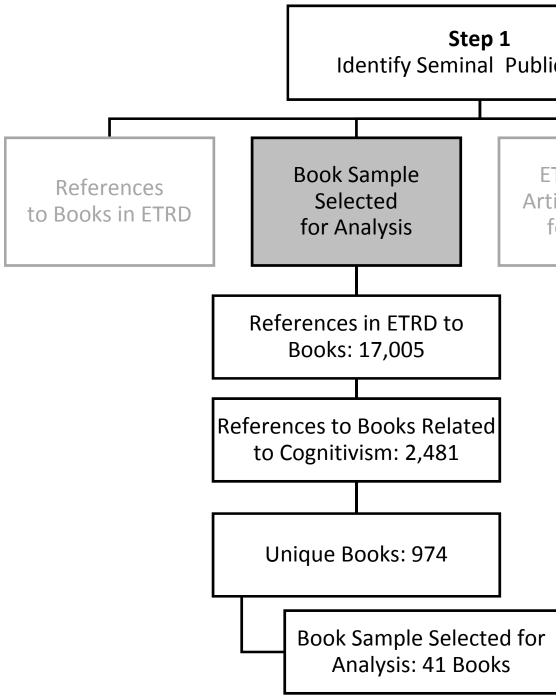

Figure 7. Overview of Book Sample Selected for Analysis

To aid in the process, the first author and publication year were extracted into a text string. This process revealed additional reference formatting inconsistencies. Common errors included reversed author names, missing chapter names, incorrect APA formatting leading to commas and periods being incorporated inconsistently, reversed editor names, missing editors, missing or questionable publication dates, inconsistency in book editions, misspellings of author and editor name(s), and incorrect book names. For example, references to the Handbook of Research for Educational Communications and Technology were written as the Handbook of Research *for*, the Handbook of Research *on*, and the Handbook of Research *in*. These subtle differences made it unfeasible to automate the process. The researcher focused on the book's title, editor(s), chapter author(s) and publication year while ignoring the name of the publisher. This is a variation on the approach used by the Thomas Reuters Web of Science database which includes the first author's last name (not the book editor), an abbreviated book title and publication year.

This process resulted in the list of 974 unique books. To provide a point of comparison, the researcher performed the Remove Duplicates function in Excel to the original list of 2,481 book references. The output revealed 2,313 unique values. Had the reference formatting been consistently in ETRD as provided in the extracted dataset from Springer, the result would have instead equaled 974 unique values. This means that that 1,339 (53.9%) of the references required correction in order for frequencies to be calculated.

The Book Sample Selected for Analysis (see Appendix B), included books cited 10 or more times over the 60-year period. This resulted in a list of 39 books. This list was supplemented with three additional editions of the Handbook of Research for Educational Communications and Technology to total 42 books for analysis.

ETRD journal articles selected for analysis. ETRD articles containing the term cognitive, cognitivism, cognition, theory, and/or theories in the titles were extracted. This resulted in a list of 74 articles, equating to 4.3% of the 1,716 articles containing references over

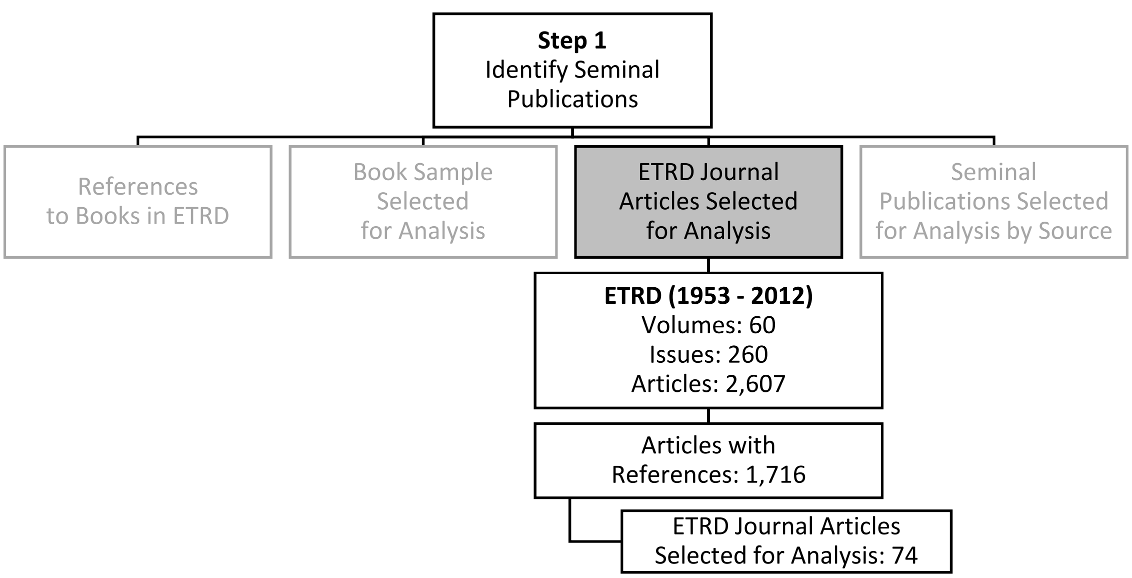

Figure 8. Overview of ETRD Journal Articles Selected for Analysis.

the 60-year period. An overview of the related sampling procedures to the research findings is provided (see Figure 8).

Seminal publications selected for analysis by source. The book and ETRD journal article samples guided the identification of seminal publications. First, book indexes were used to identify pages related to the terms cognitive, cognitivism and cognition. Pages recommended for further information were also reviewed. In the ETRD journal articles, a search was performed in each article to identify citation contexts. Four of the 42 books did not include a subject index including Bruner (1966), Duffy (1992), Glaser (1967), Lave (1988) and Shannon (1949). Two book editions were not available through the library or interlibrary loan and were substituted with available editions including Hilgard (1964) substituted with Hilgard (1948), and Slavin (1995) substituted with Slavin (1990). Johnson (1989) did not arrive through interlibrary loan within the timeframe needed to be included in the process. A total of 6,343 references were individually copied from the books and ETRD articles and pasted into the dataset. A summary of the Seminal Publications Selected for Analysis by Source is provided (see Appendix C). The leading five contributing sources provided 3,255 (51.3%) of the dataset. The largest contribution came from the Berliner and Calfee's Handbook of Educational Psychology (1996) with 845 publications or 13.3% of the dataset. In contrast, the four editions of the Handbook of Research on Educational Communications and Technology together accounted for 1,830 (28.9%) while the journal articles in ETRD contributed 672 (10.6%).

Step 2: Identify Seminal Publications Cited in ETRD

Seminal publications cited in ETRD. The seminal publications cited within the samples from Step 1 were cross referenced with the references cited in ETRD over the 60-year period. In order for the references to be compared across datasets, the differences among the same references were eliminated. The first step in the process was to create a text string containing the first author and year of each reference. Sorting on this field placed the references which had the most likelihood of being the same in close proximity. Through a line by line comparison, a final list of 9,215 rows of references was created. This process resulted in 1,760 unique references, 884 (50.2%) to journal articles and 876 (49.8%) to other sources (see Figure 9). The content analysis required for the typology development is limited to the sample published in journals.

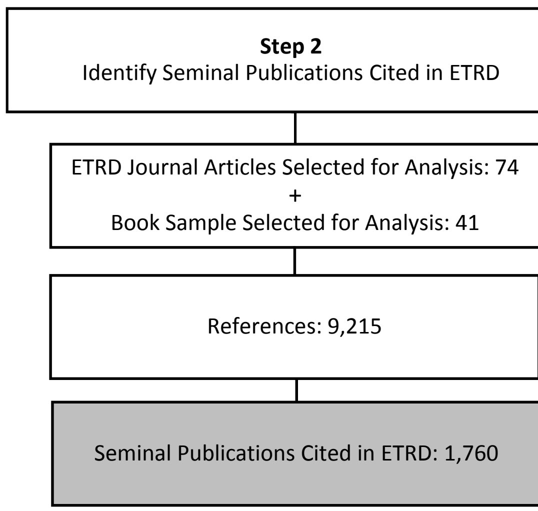

Figure 9. Overview of Seminal Publications Cited in ETRD

The researcher performed the Remove Duplicates function in Excel to the original list of 9,215 references. The output revealed 7,853 unique values. Had the reference formatting been consistently the result would have instead equaled 1,760 unique values. This means that that 6,093 (66.1%) of the references required correction in order for frequencies to be calculated.

Step 3: Select a Sample of Seminal Publications Cited in ETRD

Research Question 1 Response: Seminal publications cited in ETRD. The proceeding steps were required to respond to Research Question 1: Which publications cited in ETRD qualify as *seminal*, that is, deemed to be foundational to a theory's creation or development over time? The analysis resulted in 1,760 unique references, of which 884 are journal articles of interest. The Top 20 Seminal Publications Cited in ETRD (1953-2012) is provided (see Appendix D).

The top five seminal publications which were each cited 10 or more times in the original sample comprised of books, handbooks and ETRD journal articles and also cited 10 or more times in ETRD over the 60-year period were selected for content analysis. Following Golden-Biddle, et al. (2006) inclusion of all related citation contexts, all seminal publications cited in ETRD were selected for aggregation and analysis over time.

RQ2: What patterns of theory symbol use emerge when references in ETRD to seminal publications are traced over time?

This section describes the patterns that emerge when the references in ETRD to the sample seminal publications are explored across three frameworks (see Figure 10). Taken together, these findings support Research Question 2: What patterns of theory symbol use emerge when references in ETRD to seminal publications are traced over time?

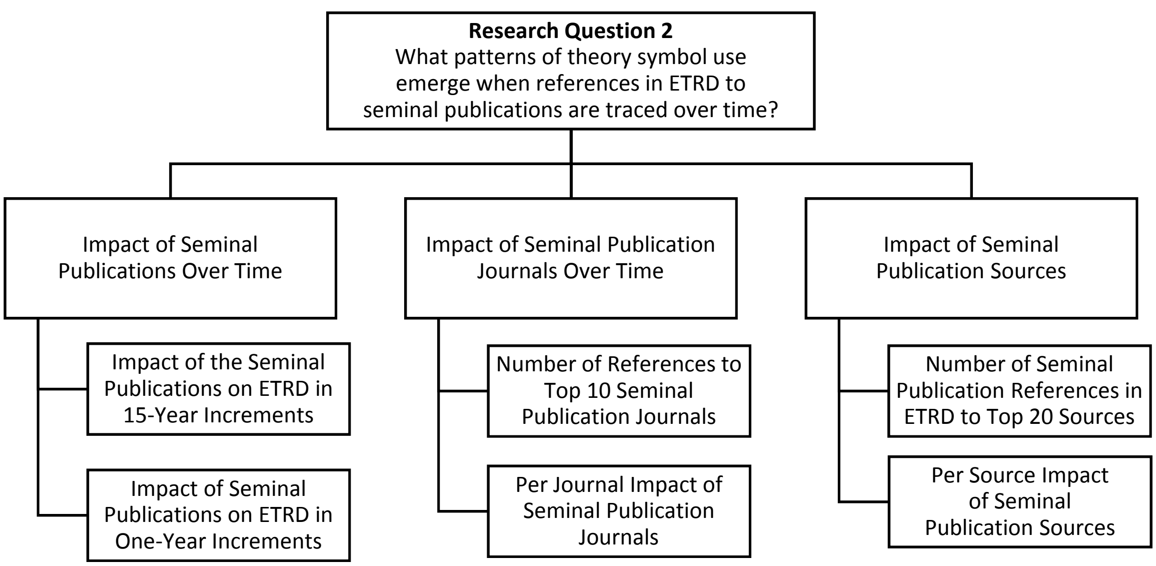

Figure 10. Research Question 2 Overview

Impact of Seminal Publications Over Time

Recall from Research Question 1, that 1,760 seminal publications are referenced in ETRD between 1953 and 2012. These publications referenced a total of 6,598 times, 3,189 (48.3%) are from seminal publications originally published in journals and 3,409 (51.6%) from other sources. Following Azar and Brock (2008) the Impact of the Seminal Publications on ETRD in 15-Year Increments (see Table 11) was calculated by dividing the number of references in ETRD to the seminal publications by the total number of references in 15-year increments. This approach is similar to the method used to calculate the impact factors in Journal Citation Reports by Thomas Reuters in which the total number of citations for a journal of interest is divided by the total number articles published in a journal for the same period (Azar & Brock, 2008).

Table 11

Impact of the Seminal Publications on ETRD in 15-Year Increments

Description	1953 -1967	1968 -1982	1983 -1997	1998 -2012	Total
Number of All References in ETRD to Seminal Publications	225	827	2,476	3,130	6,598
Number of References in ETRD	4,881	8,215	13,198	23,281	49,575
Impact of All References in ETRD to Seminal Publications	4.6%	10.1%	18.3%	13.4%	13.3%

Over the 60-year period, the seminal publications have had a 13.3% impact on ETRD. In other words, 86.7% of the references in ETRD over the 60-years were to publications other than those that were categorized by this study as seminal. The 15-year period with the lowest impact was from 1953 to 1967 (4.6%) while the highest impact was between 1983 and 1997 (18.3%). However, a review of the Impact of Seminal Publications in One-Year Increments reveals that annual impact peaked at 24.6% in 1992 (see Figure 11).

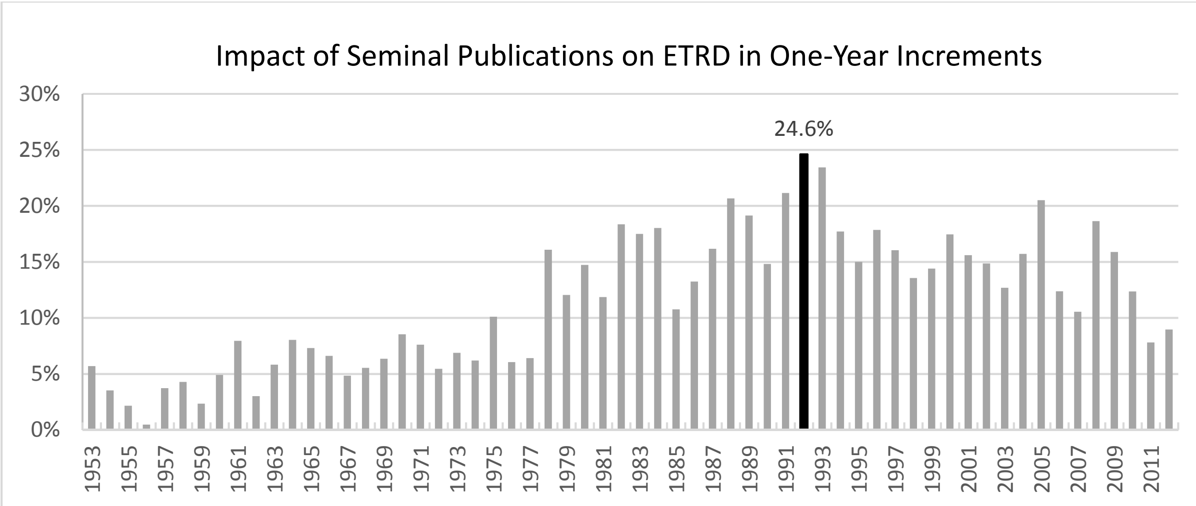

Figure 11. Impact of Seminal Publications on ETRD in One-Year Increments.

Impact of Seminal Publication Journals Over Time

The Number of References to Top 10 Seminal Publication Journals (see Appendix E) indicates that the highest ranked journal is ETRD, with a total of 566 references to seminal publications between 1953 and 2012. ETRD retained this rank over the four, 15-year increments, however the other leading journals for the 60-year period fluctuated in rank. The largest shift was experienced by American Psychologist, which was ranked fifth between 1953 to 1967, but dropped to thirteenth by 1998 to 2012. The Journal of Educational Psychology remained fairly steady, fluctuating between second and third.

Following Azar and Brock (2008), the Per Journal Impact of Seminal Publication Journals (see Appendix F) is calculated by dividing the number of references to a seminal publication from a given journal by the total number of references to seminal publications in all journals. As with the frequency based method for calculating rank, ETRD has the highest impact, as it serves as the source of 17.7% of the seminal publication references over the 60-year period. Note though that impact of ETRD peaked between 1953 and 1967, with an impact of 50.8%, but decreases to 14.9% between 1983 and 1997 when the number of references to seminal publications increased.

Impact of Seminal Publication Sources

Recall that seminal publications were identified by aggregating the findings from different sources of data including 39 books, four handbooks and a set of 74 ETRD articles. The resulting references related to cognitivism were then aligned to the references in ETRD over the 60-year period. This process required the alignment of two datasets with an unequal number of data points. For example, Salomon (1974) was cited by the sources six times, but was cited in ETRD only five times. Similarly, Brown, Collins & Duguid (1989) was cited in the original sources of data 20 times and cited in ETRD 80 times between 1953 and 2012. For this reason, a fractional counting method was used to credit the seminal publications cited in ETRD to the original sources based on their contribution. Fractional counting is commonly used in citation analysis to assign credit to co-authors contributing to a single publication (Rousseau, 1992; Egghe, 2008).

The Number of Seminal Publication References in ETRD to the Top 20 Sources (see Appendix G) indicates that the highest ranked source is ETRD, with a total of 1,539 references to the seminal publications between 1953 and 2012. ETRD retained this rank when the references were explored by those to journal articles (895 references) and non-journal articles (644 references). Even further, the top five sources by rank were the same across data sets. The largest variance in ranking occurred for the 2014 edition of the Handbook of Research on Educational Communications and Technology which was ranked 10th for references to journals and 26th for non-journal references.

The Per Source Impact of Seminal Publication Sources (see Appendix H) is calculated by dividing the number of seminal publication references in ETRD from a given source, as calculated through fractional counting, by the total number of references from all sources. For example, the number of seminal publications contributed through the analysis of one of the discipline handbooks, divided by the total number of seminal publication references gathered from all the handbooks, books and ETRD journal articles used in the study. As with the frequency based method for calculating rank, ETRD has the highest impact, as it serves as the source of 23.3% of the seminal publication references over the 60-year period. The next five highest ranking sources are the 2004, 2008 and 1996 editions of the Handbook of Research on Educational Communications and Technology and the 1996 edition of the Handbook for Educational Psychology. This ranking holds steady across all data sets. Note that these top 20 sources account for 94.2% of the seminal publication references in ETRD, while the top five account for 69.9% of the impact. In other words, had the top 5 sources been the only sources selected for the study, approximately 70% of references would have been identified.

Research Question 2 Response: Patterns of theory symbol use over time

This section explored Research Question 2 across three frameworks: 1) the impact of seminal publications over time, 2) the impact of seminal publication journals over time and 3) the impact of seminal publication sources. From 1953 to 2012, the seminal publications related to cognitivism had a 13.3% impact on ETRD. The lowest impact was from 1953 to 1967 (4.6%). The impact peaked from 1983 to 1997 (18.3%) with the highest single year impact reaching 24.6% in 1992. ETRD served as the largest source of seminal publication references to journals identified for the study (17.7%). The most noteworthy finding is that 69.9% of the impact came from only five sources including ETRD and disciplinary handbooks.

RQ3: How can emergent patterns support a typology of theory symbol use in IDT academic publication?

Emergent patterns to support a typology of theory symbol use are explored through manifest and latent variables identified through a multistep process in order to respond to Research Question 3: How can emergent patterns support a typology of theory symbol use in IDT academic publication (see Figure 12)?

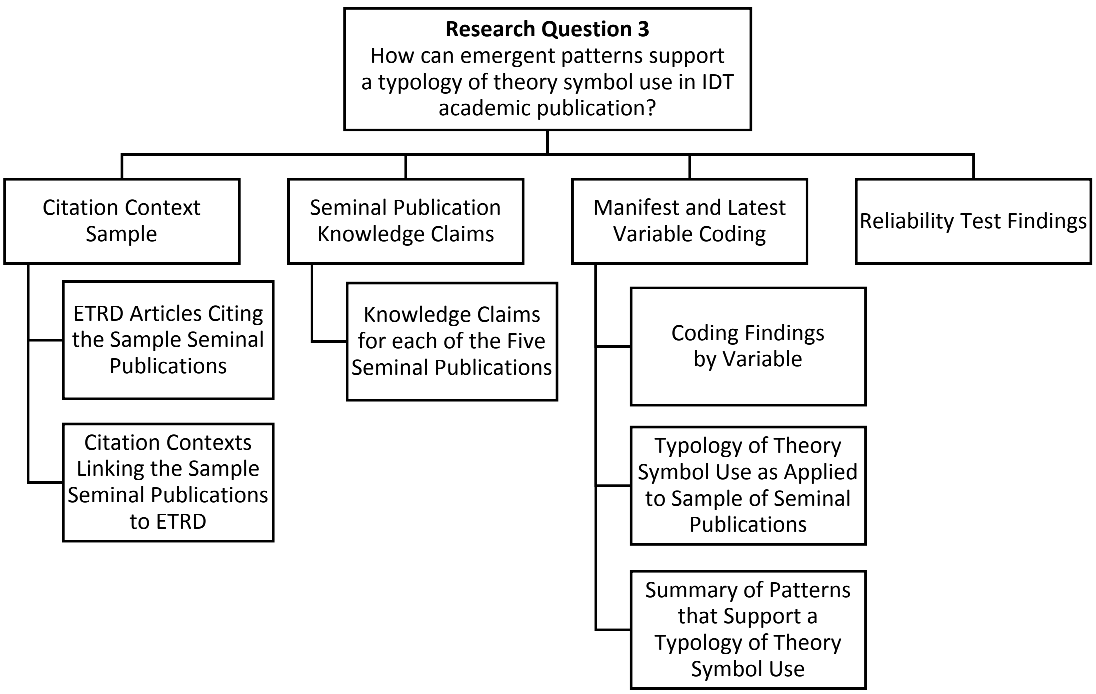

Figure 12. Research Question 3 Overview

Citation Context Sample

The first step in exploring patterns of theory symbol use was to extract the citation contexts which link articles in ETRD to the seminal publications. The selected sample of five seminal publications were incorporated into 320 citation contexts within 165 articles published in ETRD between 1953 and 2012. ETRD Articles Citing the Sample Seminal Publications (Appendix I) and Citation Contexs Linking the Sample Seminal Publications to ETRD (Appendix J) are provided.

Seminal Publication Knowledge Claims

Knowledge claims were developed for each of the five seminal publications selected for the study (see Appendix K). The researcher referred to the asserted knowledge claims and detailed appendices in Golden-Biddle et al. (2006) for guidance in developing the bulleted, often brief lists of knowledge claims that incorporate key words from the seminal publication. The researcher referred to the language of the seminal publications to guide the selection of knowledge claims, such as "…some summarizing remarks" (Miller, 1956, p. 95), "summary of main findings…" (Palincsar & Brown, 1984, p.167), "In sum…" (Salomon, Perkins & Globerson, 1991, p. 4), "In this paper, we have described…" (Sweller, van Merrienboer & Paas, 1998, p. 289), and "Thus, in a significant way…" (Brown & Duguid, 1989, p.33). While the knowledge claims were developed through careful review, the selections were subjective.

Manifest and Latent Variable Coding

Manifest variable coding. The citation contexts were examined in terms of theory symbol age, citing article topic, multiplicity, location of citation, citation clustering, citation integration and citation style.

Variable 1: Theory symbol age. Theory symbol age is the difference between the publication year of the citing article and the cited seminal article. For comparison, the average age was calculated across the 6,598 seminal publication citations and the 49,575 citations in ETRD from 1953 to 2012 (see Table 12). The weighted average theory symbol age for the top five seminal publications (15.5) is older than the weighted average age for all seminal articles (12.4) and all articles in ETRD from 1953 to 2012 (9.4), as provided in Variable 1: Seminal publication theory symbol age (see Table 12). In other words, ETRD article authors incorporate seminal publications related to cognition that on average, are older than the other articles that are selected. Note too that the weighted average theory symbol age for seminal journal publications (10.9) is younger than that for seminal non-journal publications (13.8).

Table 12

Variable 1: Seminal Publication Theory Symbol Age

Description	Theory Symbol Age
Brown, Collins & Duquid (1989)	11.2
Miller (1956)	34.2
Palincsar & Brown (1984)	18.6
Salomon, Perkins, & Globerson (1991)	8.7
Sweller, Merreinboer & Paas (1998)	9.8
Weighted Average for Total Sample (5 articles, 166 citations)	15.5
Weighted Average for All Seminal Publication Citations (6,598)	12.4
Weighted Average for All Seminal Journal Publication Citations (3,189)	10.9
Weighted Average for All Seminal Non-Journal Publication Citations (3,409)	13.8
Weighted Average Citation Age for ETRD	9.4

Plotting the frequency of the theory symbol age for all seminal publications, the top five seminal publications as compared to all articles in ETRD reveals a pattern reported in prior research (see Figure 12). The ETRD articles have a higher percentage of its citations peaking at year 3-4, with a steep decline, whereas the average theory symbol age for all seminal publications peaked at 3 years, but remained relatively steady until year 7 when it slowly declines. The plot of the top five seminal publications reveals a more erratic pattern that peaks in year 6. McCain (2011) offers an in-depth review of citation patterns and cites Costas, van Leeuwen, and van Raan (2010) who studied what the durability of citations, finding that on average, documents peaked early, at years 4-5 whereas others peaked later at 10-11 years.

McCain and Turner (1989) had originally associated citations that peaked early with research results, and those peaking later with theory and methodology. These patterns vary by subject area and discipline (McCain, 2011).

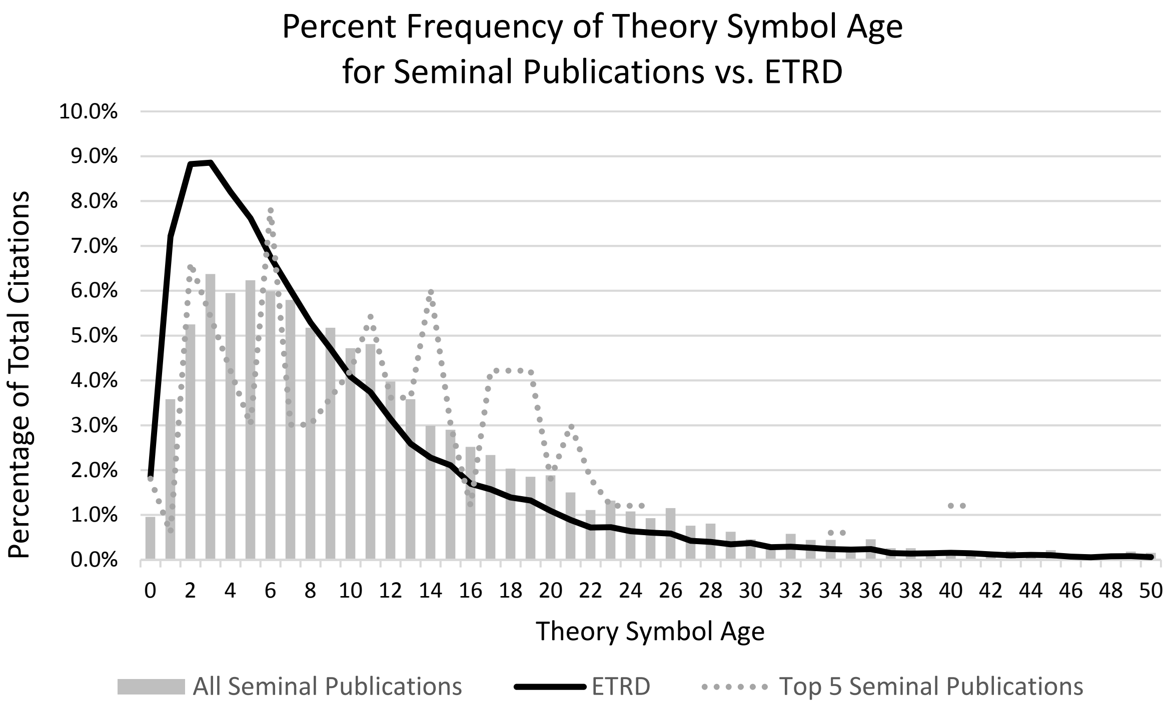

Figure 12. Percent Frequency of Theory Symbol Age for Seminal Publications vs. ETRD

Variable 2: Author and writer relation. This variable indicates if any of the publication author(s) names are also the name(s) of the citing article writer(s). Citations to one seminal article, Sweller, Merreinboer & Paas (1998), were coded as Parallel, meaning that the co-writers from the citing article also served as the author of the seminal article. While there were eight citing articles coded as Parallel, they accounted for 14 citation contexts. All other citation contexts across the sample were Unrelated.

Variable 3: Citing article topic. Following and Pettigrew and McKechnie (2001), the topic was identified by the first keyword, abstract and introduction and coded as Variable 3. Citing article topics varied, with 113 unique topics across the sample. To aid in comparison, the researcher summarized the topics into larger categories. For example, the category cognition includes cognitive load, cognitive load theory, metacognition, and information processing, etc. The most prevalent category was cognition, applicable to 24.1% of the citing articles. The second highest ranking category was tied with technology and media, and instructional design and instructional models, applicable to 12.7% of the citing article topics. Together these account for 49.4% of the citations.

Variable 4: Multiplicity. Following Johnston, Piatti, and Torgler (2013), "citations per published page" rather than the total number of citations (p. 1026) is recorded the Multiplicity Variable to control for the differences in the number of pages in the articles. The average citations per page to the seminal publications is .12. The range across the publications includes a low of .08 for Miller (1956) and Palincsar & Brown (1984) and a high of .15 for Sweller, Merreinboer & Paas (1998). Brown, Collins, and Duguid (1989) received the greatest number of citations for a given article. Two articles referenced the publication a total of 20 and 10 times each, with the majority of contexts included within tables.

Variable 5: Location of citation. This variable refers to the section in which the theory symbol is incorporated into the citing article. Following Zhang et al. (2013), seven codes were applied: abstract, introduction, literature review, methodology, results/discussion, conclusion and others as specified. All citations were categorized with zero allocations to the Other category. The majority of citations to the seminal publications were in the literature review and framework sections (70.6%). The second highest location was the Introduction (17.8%) (see Table 13).

Table 13

Variable 5: Location of Citation

	Total Sample No.	Total Sample Percent	Brown, Collins & Duquid (1989) Percent	Miller (1956) Percent	Palincsar & Brown (1984) Percent	Salomon, Perkins, & Globerson (1991) Percent	Sweller, Merreinboer & Paas (1998) Percent
Abstract	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Introduction	57	17.8%	17.6%	9.1%	29.0%	5.6%	21.0%
Literature review & Framework	226	70.6%	76.7%	81.8%	51.6%	66.7%	58.1%
Methodology	5	1.6%	0.0%	6.1%	6.5%	0.0%	1.6%
Results, Discussion & Future Research	27	8.4%	5.1%	3.0%	12.9%	11.1%	17.7%
Conclusion	5	1.6%	0.6%	0.0%	0.0%	16.7%	1.6%
Other	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total	320	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Variable 6: Citation clustering. Citation clustering is the number of citations included in with the theory symbol citation within the same sentence (see Table 14). The majority (42.2%) of the citations included no additional citations within the same sentence. However, small clusters accounted for a close 38.1% of the citation contexts. Results varied across the seminal publications, for example 67.6% of the citation contexts to Miller (1956) contained no additional citations within the same sentence. This is in contrast to Palincsar & Brown (1984) with 45.2% of the citation contexts containing 1 to 2 additional citations; this publication received the greatest number of additional citations with 13 additional citations being included within a single context within the Literature Review.

Table 14

Variable 6: Citation Clustering Summary

	Total Sample No.	Total Sample Percent	Brown, Collins & Duquid (1989) Percent	Miller (1956) Percent	Palincsar & Brown (1984) Percent	Salomon, Perkins, & Globerson (1991) Percent	Sweller, Merreinboer & Paas (1998) Percent
None (no additional citations)	135	42.2%	37.3%	67.6%	25.8%	63.2%	41.3%
Small cluster (1 to 2 additional citations)	122	38.1%	39.0%	17.6%	45.2%	26.3%	44.4%
Large cluster (3 or more additional citations)	63	19.7%	23.7%	14.7%	29.0%	10.5%	14.3%
Total	320	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Variable 7: Citation integration. Following Jaidka, Khoo, and Na (2013), there are two categories of citation integration, explicit citations which include the author(s) name in the cited text and implicit which include the name in the parenthesis. The researcher modified the Codebook during the Pilot Study to categorize citations included in tables as implicit. The majority of citations to the seminal publications were implicit (87.8%). The remaining 12.2% were classified as explicit. These trends held true across all seminal publications.

Variable 8: Citation style. The citation style variable indicates if the citation is a summary or quotation of prior work. The categories included for this study include summary (no quotation), short quote (quotation is contained within a single sentence), and long quote (quotation covers two or more sentences). The researcher modified the codebook during the Pilot Study to clarify that the page numbers must be included to qualify text as a quotation. For example, one to two words included in quotation marks for emphasis, but without providing the page number of the original source is not considered a quotation. The majority of sample citations were categorized as Summary (97.5%), meaning no quotation was included. There was only one citation context out of 320 total that was coded as Long Quote (.3%) in which the quotation was two or more sentences long. The passage cited Salomon, Perkins, & Globerson (1991). Seven (2.2%) citation contexts contained short quotations contained within a single sentence, six of these citations cited Brown, Collins & Duguid (1989).

Variable 9: Theory symbol materialization. The content that the citing article transfers from the seminal article through citation is captured in this final variable. Whereas Variable 1 through Variable 8 are all related to characteristics of citation contexts, only Variable 9, Theory Symbol Materialization, considers the content transferred from the cited to citing article through citation. The four variable codes include Comprehensive, Selective, Peripheral and Typification. The three levels of knowledge claims include Level 1 (abstract theoretical), Level 2 (general argument or findings) and Level 3 (detailed argument or findings) (Golden-Biddle et. al., 2006). Following Golden-Biddle et. al. (2006), the prevalence of theory symbol materialization is provided by frequency across the sample and frequency per seminal publication (see Tables 15 and 16).

Table 15

Variable 9: Theory Symbol Materialization Frequency by Seminal Publication

	Total Sample		Brown, Collins & Duquid (1989)	Miller (1956)	Palincsar & Brown (1984)	Salomon, Perkins, & Globerson (1991)	Sweller, Merreinboer & Paas (1998)
	Number	Percent	Number	Number	Number	Number	Number
Comprehensive	2	.6%	0	0	0	0	2
Level 1 Selective	*44*	*13.8%*	*26*	*4*	*5*	*3*	*6*
Level 2 Selective	*85*	*26.6%*	*51*	*2*	*8*	*7*	*17*
Level 3 Selective	*90*	*28.1%*	*34*	*16*	*7*	*3*	*30*
Total Selective	219	68.4%	111	22	20	13	53
Peripheral	28	8.8%	15	3	9	1	0
Typification	71	22.2%	50	8	2	4	7
Total	320	100.0%	176	33	31	18	62

Table 16

Variable 9: Theory Symbol Materialization Percentage by Seminal Publication

	Total Sample		Brown, Collins & Duquid (1989)	Miller (1956)	Palincsar & Brown (1984)	Salomon, Perkins, & Globerson (1991)	Sweller, Merreinboer & Paas (1998)
	Number	Percent	Percent	Percent	Percent	Percent	Percent
Comprehensive	2	.6%	0.0%	0.0%	0.0%	0.0%	3.2%
Level 1 Selective	*44*	*13.8%*	*14.8%*	*12.1%*	*16.1%*	*16.7%*	*9.7%*
Level 2 Selective	*85*	*26.6%*	*29.0%*	*6.1%*	*25.8%*	*38.9%*	*27.4%*
Level 3 Selective	*90*	*28.1%*	*19.3%*	*48.5%*	*22.6%*	*16.7%*	*48.4%*
Total Selective	219	68.4%	63.1%	66.7%	64.5%	72.2%	85.5%
Peripheral	28	8.8%	8.5%	9.1%	29.0%	5.6%	0.0%
Typification	71	22.2%	28%	24%	6%	22%	11%
Total	320	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Comprehensive theory symbol materialization. Two citations (.6% of total citations and 3.2% of the seminal publication) carried forward knowledge claims from Levels 1 and 2. This finding is consistent with Golden-Biddle et al. (2006) and Mizruchi and Fein (1999) in that this category was the least frequently applied. Both citations were from the same seminal publication, Sweller, Merreinboer & Paas (1998), within the Literature Review/Framework and Results/Discussion/Future Research sections and both citing articles were coded as cognitive load and cognitive load theory. One of the citations was also coded with Variable 2, Author and Writer Relation, as Parallel, meaning that a co-writer from the citing article is an author of the seminal publication.

Selective theory symbol materialization. The most frequent type of materialization is selective, accounting for 68.4% (111) of all contexts, with the majority at Level 3 (28.1%) and Level 2 (26.6%). The remaining 13.8% of the citations were theoretical or abstract and coded as Level 1. The prevalence of selective materialization was consistent across the seminal publications. These findings are consistent with Golden-Biddle et al. (2006) which found that 55% of the citations were Level 2 or 3.

Nearly half (48.5%) of the Miller (1956) citations materialized as Level 3 knowledge claims: theory of information concepts (inputs, outputs, channel capacity, information transmitted and variance), the description of absolute judgement, the span of immediate memory, and recoding, such as

> STM acts essentially as a transitional buffer containing information units to be acted upon. It does not, by itself, support permanent storage, but instead selectively regulates the exchange of information among ongoing instruction, prior knowledge, and long-term storage of lesson information. Due to its transitional nature, STM has limited capacity, generally estimated to be seven (plus or minus 2) informational or idea units (Miller, 1956). (Hannafin & Rieber, 1989, p. 94)

However, only 6.1% of the Miller (1956) citations materialize Level 2 knowledge which includes general statements about the theory of information, absolute judgement, and the limits of immediate memory capacity. For example, the citation below is related to processing capacity as is the Level 3 example above, however it uses more general knowledge claims.

> As working memory has a limited processing capacity (Miller, 1956) the efficiency of a thematic map for a given task should determine the effectiveness of the image formed from this map for integrating new information. (Rittschof & Kulhavy, 1998, p. 20)

Peripheral theory symbol materialization. Only 8.8% of the total citations carried forward knowledge claims not included as Levels 1, 2 or 3. The highest percentage of peripheral citations for a given seminal publication occurred for Palincsar & Brown (1984) with 29% (9 citations). One citation was included in Methodology, two were in the Introduction, while the remaining citations were included in the Literature Review and Framework sections. The average theory symbol age for these peripheral citations was 18.7% nearly identical to the average for the publication (18.6%). Peripheral citations to Brown, Collins & Duguid (1989) were lower in frequency (8.5%) yet higher in number (15 citations), all of which appeared in the Literature Review and Framework sections. While these peripheral citations varied by areas of focus, five connected the work of others, such as,

> Brown et al. (1989) based many of their ideas on the work of Lave, who with Wenger developed theories about learning and working within COP (Lave and Wenger 1991). (West, 2008, p. 317)

Had the peripheral citations been related to a distinct set of ideas, it would have raised the question about their omission in the knowledge claims.

Consistent with Golden-Biddle et al. (2006) the study revealed a preference for specific knowledge claims over others. For example, of the Level 3 materializations for Sweller, Merreinboer and Paas (1998), the Level 3 knowledge claim related to germane cognitive load was included in 8 (25%) of the citations. On the contrary, only one citing article included a list of recommended instructional design strategies which originally accounted for over 40% of the pages within the original seminal publication (20 pages out of 47 total pages).

Typification materialization. Approximately 22% (71of the total sample) of the theory symbols contained typifications that restated knowledge claims as general characterizations. The highest frequency of typifications from a single seminal publication was Brown, Collins & Duguid (1989) (50 citations, 28% from the seminal publication). Similar to Golden-Biddle's (2006) findings, these citations referred to the seminal publication as a piece of a larger body of work, or a specific component within that work. A few examples follow.

> Contemporary theoretical perspectives such as constructivism (Jonassen, 1991), situated cognition (Brown, Collins, & Duguid, 1989), and cognitive flexibility (Spiro, Feltovich, Jacobson, & Coulson, 1991) emphasize the centrality of the learner to understanding. (Land & Hannafin, 1996, p. 37)

> Many emerging learning environments derive their foundations from areas such as constructivism (Jonassen, 1991) and situated cognition (Brown, Collins, & Duguid, 1989). (Hannafin, Hannafin, Land, & Oliver, 1997, p. 104)

Another form of typification is to categorize the researchers within their area of study. For example, the citation below refers to the researchers based on their body of work, in this case cognitive load.

> In particular, it is argued by cognitive load theorists (see Paas, Renkl, & Sweller, 2003; Sweller, 2003; Sweller et al., 1998) that information stored in long-term memory can vastly increase the capacity of working memory. (Clarke, Ayres & Sweller, 2005, p. 16).

Reliability Test Findings

After the coding was completed, a reliability study was performed with a random sample of 10% of the citation contexts across seminal publications. The intra-coder agreement was calculated at 100% for all variables except two that included the most subjectivity. Variable 3, Topic, was calculated at 97%, with consistent coding across 31 of the 32 sample contexts. Variable 9, Materialization, was 94% with 30 of the 32 contexts coded the same. The discrepancy with the Materialization was in determining when the citation becomes so general that it crosses over from theoretical and abstract to typification.

RQ3 response: Patterns that Support a Typology of Theory Symbol Use

The purpose of this research study was to develop a typology of theory symbol use in IDT academic publication. A review of literature supported the identification of nine variables which served as the typology categories including theory symbol age, citing article topic, multiplicity, location of citation, citation clustering, citation integration, citation style, and theory symbol materialization. The careful review of citation contexts connecting five seminal publications related to cognitivism to articles published ETRD from 1953 to 2012 allowed the researcher to explore these variables in context and develop a typology of the ways theory symbols are materialized in IDT academic publication. The findings suggest that there are a number of different strategies that researchers use when incorporating the work of others. As Golden-Biddle et al. (2006) explain

> citations not only differently materialize prior knowledge but they often do not mean the same thing; a citation is not a citation is not a citation. Rather, and importantly, the meaning of citations is disclosed in how, not how much, they variously materialize prior knowledge content in developing or extending their ideas. (p. 249)

Variable 9, Theory symbol materialization, was the only latent variable in the study. Each context was labeled as either comprehensive, selective, peripheral or typification depending on the content transferred from the cited to the citing article. While the results varied by seminal publication and across the total sample, the researcher demonstrated that the typology could be applied to a variety of contexts.

Exploring patterns of theory symbol use over time (Research Question 2), highlighted the value of pairing citation details required for the sampling process with content analysis. For example, citation patterns were studied across seminal publications, seminal publication journals and seminal publication sources. The analysis revealed an impact (13.3%) of cognitivism on ETRD as reflected in the citation patterns of the seminal publication sample. This impact was at its highest point from 1983 to 1997 (18.3%), with the most influential year being in 1992 (24.2%). The lowest impact was between 1953 and 1967. The majority (69.9%) of the impact originated from the IDT handbooks, ETRD articles and a single handbook from Educational Psychology. In other words, had the researcher not included the other 37 books, only 30% of the seminal publications related to cognitivism would have been undiscovered in the study.

Supplementing content analysis with citation analysis provided a more comprehensive view of theory symbol use in IDT academic publication than has been completed to date. A Typology of Theory Symbol Use as Applied to a Sample of Sseminal Publications Cited in ETRD is provided (see Appendix L).

The final Typology of Theory Symbol Use (see Table 17) includes nine categories, each of which have been successfully applied to a sample of seminal publications cited in IDT academic articles. While this research could be extended to include the function the theory symbol serves within a citation context, that was beyond the scope of this study. There is extensive prior research which could support those efforts.

Table 17

Typology of Theory Symbol Use

Number	Category	Types
1	Theory symbol age	(specify)
2	Author and Writer relation	Reciprocal, Parallel, Unrelated
3	Citing article topic	(specify)
4	Multiplicity	Single, Multiple, Repeated
5	Location of citation	Abstract, Introduction, Literature Review/ Framework, Methodology, Results/Discussion/ Future Research, Conclusion, Other
6	Citation clustering	None, Small cluster, Large cluster
7	Citation integration	Explicit, Implicit
8	Citation style	Summary, Short quote, Long quote
9	Theory symbol materialization	Comprehensive, Selective, Peripheral, Typification

Chapter 5 - Discussion

The purpose of this study was to trace theory symbol use over time by exploring the citation history of seminal publications and to provide a typology of theory symbol use in IDT academic publication. The researcher completed a review of literature by applying a systems theory framework to study the influence of discourse, theory and citation on IDT disciplinary knowledge. Systems theory supported the exploration of components that form a whole (Watson & Reigelugh, 2008) as well as their impact on the entire system (Banathy, 1967; Gagne, 1962). Next, the researcher explored the application of theory through citation, called the application context (Martens, 2004; Martens & Goodrum, 2006). Lastly, the researcher studied the role of citation in academic publication. Recall that a citation is a collection of words and indexing methods which align to a list of references included at the end of the document and provide details for locating the original source (Borgman, 1989; Powley & Dale, 2007). This review revealed a wide range of research about the role of theory in supporting disciplinary knowledge, and a lack of research which explores how theory contributes to the development of IDT through academic publication. Following recommendations from Bort and Keiser (2011), Jacobson (2007), Martens (2004), and Pettigrew and McKechnie (2001) to study the use of theory in academic publication, the application of theory at the point of citation and provide a typology of the theory application, the researcher developed three questions:

1. Which publications cited in ETRD qualify as *seminal*, that is, deemed to be foundational to a theory’s creation or development over time?
2. What patterns of theory symbol use emerge when references in ETRD to seminal publications are traced over time?

3. How can emergent patterns support a typology of theory symbol use in IDT academic publication?

Contribution

The primary contribution of this study was a typology of theory symbol use in IDT academic publication. As Baskerville and Dulipovici (2006) argue, it is valuable to understand the application of theory because theory is used to support research arguments, methodology and in turn the development of other theories. This section briefly reviews the typology through a lens of comprehensive analysis, systematic analysis, and reliable analysis (Jang, 2008). Comprehensive analysis refers to the composition of elements (Jang, 2008). Following Golden-Biddle, Locke, and Reay (2006), the analysis was performed across all articles citing the seminal publication sample. Applying the typography over a 60-year period allowed the researcher to judge its feasibility over a broad sample of contexts. The second type of analysis, systematical, refers to "the framework as a set of analysis procedures" that supports the researcher in making inferences from the text (Jang, 2008, p. 103). In this study, the researcher developed coding procedures and a codebook by performing a review of literature and pilot study. The final type of analysis is reliability (Jang, 2008, p. 103) which is used to support quality inferences from the text (Holsti, 1969). The researcher performed a reliability test across 10% of the citation contexts across the seminal publication sample. The intra-coder agreement was calculated for all variables as discussed in Chapter 4, Findings. The latent variable called Materialization resulted in the lowest intra-coder agreement calculation with 94% (30 out of 32) contexts coded the same.

Exploring the impact of seminal publications over time uncovered patterns consistent with the influence of cognitive theory in IDT. For example, the researcher calculated the impact of seminal publications related to cognitivism finding that from 1953 to 2012, the publications had a 13.3% impact on ETRD. The lowest impact was from 1953 to 1967 (4.6%). The impact peaked from 1983 to 1997 (18.3%) with the highest single year impact reaching 24.6% in 1992. Similarly, "while cognitive psychology emerged in the late 1950s, it was not until the late 1970s that cognitive science began to have its influence on instructional design" (Sackney & Mergel, 2007, p. 83). The peak of the seminal publication impact beginning in 1983 is understandable, given that it wasn't until the late 1970s that cognitive science began its influence in IDT. For example, recall that the average theory symbol age for all seminal publications peaked at 3 years, and remained relatively steady until year 7. This means that on average, a seminal publication published in the late 1970s would have its peak impact from the early to mid-1980s, loosely aligning with the peak impact of seminal publications in ETRD beginning in 1983. While further research would be necessary to fully support this argument, the findings of this study suggest that it is conceivable that the history of theory in IDT can be revealed through the citation patterns of seminal publications related to a given theory.

In the present study, a review of disciplinary handbooks and a key research journal served as the primary source in identifying the majority of seminal publications related to the theory of interest. It is recommended that novice researchers become familiar with seminal publications because they serve as the foundation of IDT as well as a "starting point for practitioners who want to develop a comprehensive understanding" (Serenko, 2013, p. 793) in the discipline of IDT. The per source impact was calculated by dividing the number of seminal publication references in ETRD from a given source, by the number of references from all sources. ETRD had the highest impact and served as the source of 23.3% of the seminal publication references from 1953-2012. Pairing seminal publications identified in ETRD with those located through a review of the 2004, 2008 and 1996 editions of the Handbook of Research on Educational Communications and Technology and the 1996 edition of the Handbook for Educational Psychology, accounted for 69.9% of the impact. This may mean that researchers publishing in ETRD located key publications through review of these publications. However, it may also mean that both the handbook authors and ETRD authors locate the seminal publications independently. Either way, it highlights the importance of disciplines developing and maintaining disciplinary handbooks to guide novice and expert researchers alike. These findings also highlight the value of setting and maintaining research standards across disciplinary publications. It is possible that because both ETRD and the IDT disciplinary handbooks in this study resulted in the identification of similar seminal publications because they are published by the same organization.

Citation counts are a widely recognized, yet imperfect, measure of influence (Kacmar and Whitfield, 2000). As Golden-Biddle, et al. (2006) argue, establishing the impact of a body of work requires that one explores the extent of content use as well as the content that is transferred through citation. Through a citation context analysis, this study represents an attempt to identify the materialization of theory symbol use at three levels including abstract/theoretical, general and detailed. While the research was limited to the level of detail, rather than the actual content transferred through citation, the results indicate considerable variety in the level of detail shared. For example, recall that only .6% of the total sample shared comprehensive knowledge claims and 28.1% shared Level 3 (detailed argument or findings) claims. Similar to Anderson and Sun's (2010) study of the influence of Walsh and Ungson (1991), this research study may suggest that the five seminal publications may have had less impact than their citation counts imply. However, before making this conclusion, research would need to be performed to compare theory symbol materialization across a variety of theories over time in order to identify differing trends.

Along these lines, this study did not uncover any consistent citation patterns either within an individual seminal publication or across the total sample that indicated that the concepts the publications established have become part of general knowledge (McCain, 2011) and cited on a more cursory basis over time. Rather, the study demonstrated an inconsistency in the level of detail of materialization. Similar to Chicksand, Watson, Walker, Radnor and Johnston's (2012) exploration of the use of theory in supply chain management, while the findings of this study demonstrate that researchers apply theory differently both in breadth and depth, it is not implied that the "research in this field is of poor quality" (p. 468). However, it does provide support for the importance of guiding novice researchers in quality research practices so that progress in the advancement of IDT may continue.

By identifying seminal publication knowledge claims to support the exploration of the Variable 9, Theory symbol materialization, the researcher recognized a potential benefit for novice researchers. For example, the students could review academic publications, organize the key takeaways into a hierarchical framework and compare the results with classmates. The standard framework may help the students develop skills needed to develop literature review summaries and better support research grounded in theory. Additionally, having awareness of the categories of the theory symbol typology may help novice researchers understand the varying ways that theory is incorporated into academic publication and develop a more critical eye when reviewing prior research.

This study extended the exploration of theory in IDT across publication outlets and longer periods of time. The traditional method for citation analysis includes downloading citations from the ISI Web of Knowledge by Thomas Reuters (Johnston et al., 2013). However, this service does not provide citations prior to 1974, nor does it provide citations for all academic journals or all books used to support academic research. This study demonstrated the feasibility of performing citation analysis with the support of off the shelf web scraping tools to extract reference details from online sources. It also demonstrated the feasibility of extracting and standardizing references and citation contexts from physical books, electronic books, and PDFs with common tools such as the Evernote Scanner App, MS OneNote, MS Excel and Adobe Acrobat Professional. The researcher tested professional optical character recognition software but found it to be more cumbersome and less accurate for foreign languages than Evernote and MS OneNote. These findings increase the opportunity for researchers to explore foundational publications which are not stored electronically, more efficiently and cost effectively.

Limitations

A potential limitation of the study is that the identification of seminal publications was dependent upon the use of key terms found within references, journal articles and book indexes. However, as Pettigrew and McKechnie (2001) and Buckland (1991) warn, limiting the definition of theory may be inadequate for identifying the varied ways that theory is applied. As a result, seminal publications which lacked the key words but still applied cognitive theory within the text may have been excluded from the study.

A similar limitation is that the study focused on seminal publications in the form of journals. According to Hicks (1999), books account for approximately 40% of all citations and have different citation patterns than journals. While a list of seminal publications in the form of books was created and used to support the citation analysis, books were not included in the content analysis which supported the final typology. Similarly, the study focused on theory symbol use in a single IDT journal and the researcher “acknowledge[s] that the data set does not necessarily provide a comprehensive coverage” of IDT (Chicksand, Watson, Walker, Radnor, & Johnston, 2012, p.468).

Another limitation is the potential for researcher error. The analysis required the researcher to organize and standardize large datasets of bibliometric data. While formulas were used to the extent possible and the researcher cross referenced the datasets to check for error, there is room for human error. Similarly, the researcher was the only coder and it is possible that another person would make different selections.

The identification of knowledge claims for the seminal publication sample also presents a limitation. While the researcher followed a process outlined in prior research, the final selection of the knowledge claims was subjective. Another researcher may have come to different conclusions even when exploring the same datasets. Further research would be required to reveal the potential impact of these limitations.

Next Steps

The primary contribution of this study was a typology of theory symbol use in IDT academic publication. Although the outcome advances our understanding of theory use, extensive research opportunities remain. A typology “represents a purposeful interpretation of reality [that] provides a way of slicing the world into parts that permit further study” (Baskerville & Dulipovici, 2006, p. 100). The resulting variables for this study including theory symbol age, author and writer relation, topic, multiplicity, location, clustering, integration, style and materialization provide a breadth analysis that enable researchers to conduct future depth analysis (Baskerville & Dulipovici, 2006). For example, the clustering of citations could be explored to reveal which theories are incorporated within close proximity, meaning that they are used in tandem to advance arguments in IDT academic research.

Another recommendation is to replicate the study to include additional theory symbols within ETRD and across IDT journals. If the process successfully supports the exploration of theory as the datasets are broadened, expanding the study to include journals outside IDT is a next logical step. Future research could also analyze theory symbol use in other publication outlets, since edited books and monographs are a large part of academic publication (Hargens, 2000). Ultimately, an analysis to better understand the interaction of multiple theories in academic publication across disciplines is recommended. For example, a network analysis could reveal how theories interact across disciplines to advance disciplinary knowledge over time. This would allow researchers “to trace the academic ancestral origins or [influence] of several theories for the purposes of identifying which disciplines [IDT and other] researchers are using as a basis for building their own theory” (Pettigrew & McKechnie, 2001, p. 70).

The research could also be extended outside of academic research. For example, pairing these findings with educational policy may reveal the ways the discipline influences and is influenced by other factors. Equipped with a better understanding, leaders can better support educational change.

Refinements that reduce manual processes are also recommended. For example, developing a universal coding system for citations and expanding the functionality of library information systems to support cross referencing across topic indexes, references, citations and publication outlets would make it more accessible for researchers to explore disciplinary knowledge and interdisciplinary scientific discovery. While this may appear similar to performing searches in current day library information systems, there is a key difference.

Current systems allow the researcher to search for terms, such as an area of focus, included within a publication such as within the body of the publication, title, abstract or keywords. An information system developed through processes similar to those used for the study would allow a researcher to quickly identify publications that serve as the foundation to an area of focus that may not include the key terms of interest. For example, nowhere in the seminal publication, Miller's (1956) titled *The magical number seven, plus or minus two*, are the terms cognitivism, cognition or cognitive used. However, it is heavily cited to support discussions about cognitivism in academic publication. This could help novice researchers or researchers from other disciplines to identify relevant research within an area of focus.

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Appendix A

Bibliometric Studies in IDT

Type	Area of Focus	Author(s)	General Method	Period	Years	Journal
Evaluative	Abstract	Drysdale, Matthews, Terekhova-Nan, Woodfield, and West (2013)	Content Analysis	2001–2010	10	IHE
Evaluative	Abstract	Hadlock et al. (2014)	Citation Count, Content Analysis	2003–2012	10	AJET
Evaluative	Abstract	Halverson, Bostwick, Cates, and West (2011)	Citation Count, Content Analysis	2001–2010	10	AJDE
Evaluative	Abstract	Young, Griffiths, Luke, and West (2014)	Content Analysis	2003–2012	10	JDE
Evaluative	Abstract	Warr, Nelson, and West (2014)	Citation Count, Content Analysis	2003–2012	10	CI
Evaluative	Article Type	Billings et al. (2012)	Citation Count, Content Analysis	2001–2010	10	JRTE
Evaluative	Article Type	Billings, Nielsen, Snyder, Sorensen, and West (2012)	Citation Count, Content Analysis	2001–2010	10	JRTE
Evaluative	Article Type	Cottle, Juncker, Aitken, and West (2012)	Citation Count, Content Analysis	2001–2010	10	JTATE
Evaluative	Article Type	Dick and Dick (1989)	Citation Count, Content Analysis	1981–1986	6	ECTJ, JID
Evaluative	Article Type	Driscoll and Dick (1999)	Citation Count, Content Analysis	1992–1996	5	ETRD
Evaluative	Article Type	Henrie, Williams, and West (2013)	Citation Count, Content Analysis	2002–2011	10	IS
Evaluative	Article Type	Juncker, Calvert, Clements, Kim, and West (2013)	Citation Count, Content Analysis	2001–2010	10	CITTE
Evaluative	Article Type	Klein (1997)	Citation Count, Content Analysis	1989–1997	9	ETRD

Type	Area of Focus	Author(s)	General Method	Period	Years	Journal
Evaluative	Article Type	Langton, Manwaring, Fry, and West (2015)	Citation Count, Content Analysis	2003–2012	10	JCHE
Evaluative	Article Type	Mayer, Francis, Harrison, McPhillen, and West (2012)	Citation Count, Content Analysis	2001–2010	10	PIQ
Evaluative	Article Type	Mott, Ward, Miller, Price, and West (2012)	Citation Count, Content Analysis	2001–2010	10	PIQ
Evaluative	Article Type	Nyland et al. (2015)	Citation Count, Content Analysis	2003–2012	10	JECR
Evaluative	Article Type	Nyland et al. (2015)	Citation Count, Content Analysis	2003–2012	10	JECR
Evaluative	Article Type	Olsen, Spring, Young, and West (2013)	Citation Count, Content Analysis	2002–2011	10	IRRODL
Evaluative	Article Type	Rackham et al. (2013)	Citation Count, Content Analysis	2002–2011	10	CE
Evaluative	Article Type	Young et al. (2014)	Citation Count, Content Analysis	2003–2012	10	JDE
Evaluative	Articles	Christensen et al. (2015)	Citation Count	2005–2014	10	IJTDE
Evaluative	Articles	Cottle et al. (2012)	Citation Count	2001–2010	10	JTATE
Evaluative	Articles	Hadlock et al. (2014)	Citation Count	2003–2012	10	AJET
Evaluative	Articles	Huglin (2009a)	Citation Count	1962–2007	46	ISPI Handbook
Evaluative	Articles	Juncker et al. (2013)	Citation Count	2001–2010	10	CITTE
Evaluative	Articles	Langton et al. (2015)	Citation Count	2003–2012	10	JCHE
Evaluative	Articles	Mott et al. (2012)	Citation Count, Quant. Analysis	2001–2010	10	PIQ

Type	Area of Focus	Author(s)	General Method	Period	Years	Journal
Evaluative	Articles	Nyland et al. (2015)	Citation Count	2003–2012	10	JECR
Evaluative	Articles	Olsen et al. (2013)	Citation Count	2002–2011	10	IRRODL
Evaluative	Articles	Oviatt, Burdis, and West (2012)	Citation Count	2000–2010	10	DE
Evaluative	Articles	Rackham et al. (2013)	Citation Count	2002–2011	10	CE
Evaluative	Articles	Shih, Feng, and Tsai (2008)	Citation Count	2001–2005	5	BJET, CE, ETRD, IETI, JCAL
Evaluative	Articles	Uzunboylu, Eris, and Ozcinar (2011)	Citation Count	1990–2008	19	(Library database)
Evaluative	Articles	Warr et al. (2014)	Citation Count	2003–2012	10	CI
Evaluative	Articles	Welch, Zabriskie, Ashton, Borup, and West (2014)	Citation Count	2002–2011	10	JCAL
Evaluative	Articles	Young et al. (2014)	Citation Count	2003–2012	10	JDE
Evaluative	Articles	Zaugg, Small, and West (2011)	Citation Count	2001–2010	10	ETRD
Evaluative	Authors	Anglin and Towers (1992)	Citation Count	1985-1990	6	ETRD, ECTJ, JID
Evaluative	Authors	Christensen et al. (2015)	Citation Count	2005–2014	10	IJTDE
Evaluative	Authors	Cottle et al. (2012)	Citation Count	2001–2010	10	JTATE
Evaluative	Authors	Hadlock et al. (2014)	Citation Count	2003–2012	10	AJET
Evaluative	Authors	Halverson et al. (2011)	Citation Count	2001–2010	10	AJDE

Type	Area of Focus	Author(s)	General Method	Period	Years	Journal
Evaluative	Authors	Henrie et al. (2013)	Citation Count	2002–2011	10	IS
Evaluative	Authors	Huglin (2010)	Citation Count	1962–2007	46	ISPI Handbook
Evaluative	Authors	Juncker et al. (2013)	Citation Count	2001–2010	10	CITTE
Evaluative	Authors	Klein (1997)	Citation Count, Content Analysis	1989–1997	9	ETRD
Evaluative	Authors	Ku (2009)	Citation Count	1989–2008	20	ETRD
Evaluative	Authors	Langton et al. (2015)	Citation Count	2003–2012	10	JCHE
Evaluative	Authors	Mayer et al. (2012)	Citation Count, Content Analysis	2001–2010	10	PIQ
Evaluative	Authors	Mott et al. (2012)	Citation Count	2001–2010	10	PIQ
Evaluative	Authors	Nyland et al. (2015)	Citation Count	2003–2012	10	JECR
Evaluative	Authors	Olsen et al. (2013)	Citation Count	2002–2011	10	IRRODL
Evaluative	Authors	Oviatt et al. (2012)	Citation Count	2000–2010	10	DE
Evaluative	Authors	Ozcinar (2009)	Citation Count	1980–2008	29	(Library database)
Evaluative	Authors	Rackham et al. (2013)	Citation Count	2002–2011	10	CE
Evaluative	Authors	Uzunboylu et al. (2011)	Citation Count	1990–2008	19	(Library database)
Evaluative	Authors	Warr et al. (2014)	Citation Count	2003–2012	10	CI
Evaluative	Authors	Welch et al. (2014)	Citation Count	2002–2011	10	JCAL

Type	Area of Focus	Author(s)	General Method	Period	Years	Journal
Evaluative	Authors	West and Borup (2014)	Citation Count, Content Analysis	2001–2010	10	AJDE, BJET, CITTE, DE, ETRD, IHE, JLS, JRTE, JTATE, PIQ
Evaluative	Authors	Young et al. (2014)	Citation Count	2003–2012	10	JDE
Evaluative	Authors	Zaugg et al. (2011)	Citation Count	2001–2010	10	ETRD
Evaluative	Books/Chap.	Huglin (2009b)	Citation Count	1962–2007	46	IHPQ, ISPI Handbook, PI, PIQ
Evaluative	Categories	Halverson et al. (2011)	Citation Count, Content Analysis	2001–2010	10	AJDE
Evaluative	Journal Subj.	Huglin (2009a)	Citation Count	1962–2007	46	ISPI Handbook
Evaluative	Journal Type	Huglin (2009a)	Citation Count	1962–2007	46	ISPI Handbook
Evaluative	Journals	Gall et al. (2010)	Citation Count	1990–2004	15	ETRD
Evaluative	Journals	Huglin (2009a)	Citation Count	1962–2007	46	ISPI Handbook
Evaluative	Keywords	Hadlock et al. (2014)	Citation Count, Content Analysis	2003–2012	10	AJET
Evaluative	Keywords	Henrie et al. (2013)	Citation Count, Content Analysis	2002–2011	10	IS
Evaluative	Keywords	Mott et al. (2012)	Citation Count, Content Analysis	2001–2010	10	PIQ
Evaluative	Keywords	Warr et al. (2014)	Citation Count, Content Analysis	2003–2012	10	CI
Evaluative	Keywords	Young et al. (2014)	Citation Count, Content Analysis	2003–2012	10	JDE
Evaluative	Learning Domain	Hsu et al. (2012)	Citation Count, Content Analysis	2000–2009	10	BJET, CE, ETRD,ETS, JCAL

Type	Area of Focus	Author(s)	General Method	Period	Years	Journal
Evaluative	Methods	Christensen et al. (2015)	Citation Count, Content Analysis	2005–2014	10	IJTDE
Evaluative	Methods	Driscoll and Dick (1999)	Citation Count, Content Analysis	1992–1996	5	ETRD
Evaluative	Methods	Hadlock et al. (2014)	Citation Count, Content Analysis	2003–2012	10	AJET
Evaluative	Methods	Halverson et al. (2011)	Citation Count, Content Analysis	2001–2010	10	AJDE
Evaluative	Methods	Hwang and Tsai (2011)	Citation Count, Content Analysis	2001–2010	10	ETRD
Evaluative	Methods	Mott et al. (2012)	Citation Count, Content Analysis	2001–2010	10	PIQ
Evaluative	Methods	Nyland et al. (2015)	Citation Count, Content Analysis	2003–2012	10	JECR
Evaluative	Methods	Olsen et al. (2013)	Citation Count, Content Analysis	2002–2011	10	IRRODL
Evaluative	Methods	Oviatt et al. (2012)	Citation Count, Content Analysis	2000–2010	10	DE
Evaluative	Methods	Rackham et al. (2013)	Citation Count, Content Analysis	2002–2011	10	CE
Evaluative	Methods	Warr et al. (2014)	Citation Count, Content Analysis	2003–2012	10	CI
Evaluative	Methods	Welch et al. (2014)	Citation Count, Content Analysis	2002–2011	10	JCAL
Evaluative	Methods	West and Borup (2014)	Citation Count, Content Analysis	2001–2010	10	AJDE, BJET, CITTE, DE, ETRD, IHE, JLS, JRTE, JTATE, PIQ
Evaluative	Methods	Young et al. (2014)	Citation Count, Content Analysis	2003–2012	10	JDE
Evaluative	Methods	Zaugg et al. (2011)	Citation Count, Content Analysis	2001–2010	10	ETRD

Type	Area of Focus	Author(s)	General Method	Period	Years	Journal
Evaluative	Publications	Henrie et al. (2013)	Citation Count	2002–2011	10	IS
Evaluative	Research Sample	Hsu et al. (2012)	Citation Count, Content Analysis	2000–2009	10	BJET, CE, ETRD,ETS, JCAL
Evaluative	Titles	Halverson et al. (2011)	Citation Count, Content Analysis	2001–2010	10	AJDE
Evaluative	Titles	Oviatt et al. (2012)	Citation Count, Content Analysis	2000–2010	10	DE
Evaluative	Topics	Hsu et al. (2012)	Citation Count, Content Analysis	2000–2009	10	BJET, CE, ETRD,ETS, JCAL
Evaluative	Topics	Hwang and Tsai (2011)	Citation Count, Content Analysis	2001–2010	10	BJET, C&E, ETRD, ETS,IETI, JCAL
Evaluative	Topics	Klein (1997)	Citation Count, Content Analysis	1989–1997	9	ETRD
Evaluative	Topics	Mayer et al. (2012)	Citation Count, Content Analysis	2001–2010	10	PIQ
Evaluative	Topics	Ozcinar (2009)	Citation Count, Content Analysis	1980–2008	29	(Library database)
Evaluative	Topics	Shih et al. (2008)	Citation Count, Content Analysis	2001–2005	5	BJET, CE, ETRD, IETI, JCAL
Evaluative	Topics	West and Borup (2014)	Citation Count, Content Analysis	2001–2010	10	AJDE, BJET, CITTE, DE, ETRD, IHE, JLS, JRTE, JTATE, PIQ
Evaluative	Topics	Zaugg et al. (2011)	Citation Count, Content Analysis	2001–2010	10	ETRD
Evaluative	Topics	Christensen et al. (2015)	Citation Count, Content Analysis	2005–2014	10	IJTDE
Evaluative	Topics	Cottle et al. (2012)	Citation Count, Content Analysis	2001–2010	10	JTATE
Evaluative	Topics	Halverson et al. (2011)	Citation Count, Content Analysis	2001–2010	10	AJDE

Type	Area of Focus	Author(s)	General Method	Period	Years	Journal
Evaluative	Topics	Juncker et al. (2013)	Citation Count, Content Analysis	2001–2010	10	CITTE
Evaluative	Topics	Langton et al. (2015)	Citation Count, Content Analysis	2003–2012	10	JCHE
Evaluative	Topics	Nyland et al. (2015)	Citation Count, Content Analysis	2003–2012	10	JECR
Evaluative	Topics	Olsen et al. (2013)	Citation Count, Content Analysis	2002–2011	10	IRRODL
Evaluative	Topics	Oviatt et al. (2012)	Citation Count, Content Analysis	2000–2010	10	DE
Evaluative	Topics	Rackham et al. (2013)	Citation Count, Content Analysis	2002–2011	10	CE
Evaluative	Topics	Warr et al. (2014)	Citation Count, Content Analysis	2003–2012	10	CI
Evaluative	Topics	Welch et al. (2014)	Citation Count, Content Analysis	2002–2011	10	JCAL
Relational	Articles	Y. Cho, Jo, Park, Kang, and Chen (2011)	Network Analysis	1988–2010	23	PIQ
Relational	Articles	Yonjoo Cho, Park, Jo, and Suh (2012)	Network Analysis	1989–2011	23	ETRD
Relational	Authors	Y. Cho et al. (2011)	Network Analysis	1988–2010	23	PIQ
Relational	Authors	Yonjoo Cho et al. (2012)	Network Analysis	1989–2011	23	ETRD
Relational	Authors	Sachs (1984)	Co-Author Analysis	1980–1983	4	JID, PIJ
Relational	Authors	Zervas, Tsitmidelli, Sampson, Chen, and Kinshuk (2014)	Co-Author Analysis	1999–2012	14	ETS
Relational	Disciplinary Boundaries	Kirby, Hoadley, and Carr-Chellman (2005)	Citation Count, Content Analysis	1991–2001	11	CSCL, ET, ETRD, ICLS, TT, JLS,

Type	Area of Focus	Author(s)	General Method	Period	Years	Journal
Relational	Invisible Colleges	Sachs (1984)	Co-Author Analysis	1980–1983	4	JID, PIJ
Relational	Topics	Y. Cho et al. (2011)	Network Analysis, Content Analysis	1988–2010	23	PIQ
Relational	Topics	Yonjoo Cho et al. (2012)	Network Analysis, Content Analysis	1989–2011	23	ETRD
Relational	Topics	Hung (2012)	Cluster Analysis, Content Analysis	2000–2008	9	(Library database)
Relational	Topics (by Country, Journal)	Hsu, Hung, and Ching (2013)	Cluster Analysis, Content Analysis	2000–2010	11	BJET, CE, JETS, ETRD, IETI, JCAL

Note. American Journal of Distance Education (AJDE), Australian Journal of Educational Technology (AJET), British Journal of Educational Technology (BJET), Computers & Education (CE), Cognition and Instruction (CI), Contemporary Issues in Technology and Teacher Education (CITTE), Computer-Supported Collaborative Learning (CSCL), Distance Education (DE), Educational Communication and Technology Journal (ECTJ), Educational Technology Research and Development (ETRD), Educational Technology (ET), Educational Technology & Society (ETS), Journal of Computer Assisted Learning (JCAL), Journals of Computing in Higher Education (JCHE), Journal of Distance Education (DE), Journal of Learning Sciences (JLS), Internet and Higher Education (IHE), Improving Human Performance Quarterly (IHPQ), Innovations in Education and Teaching International (IETI), International Conference of the Learning Sciences (ICLS), International Journal of Technology and Design Education (IJTDE), International Review of Research in Open and Distance Learning (IRRODL), Instructional Science (IS), International Society for Performance Improvement's Handbook (ISPI Handbook), Journal of Computer-Assisted Learning (JCAL), Journal of Educational Computing Research (JECR), Journal of Instructional Development (JID), Journal of Learning Sciences (JLS), Performance and Instruction Journal (PIJ) , Journal of Research on Technology in Education (JRTE), Journal of Technology and Teacher Education (JTATE), Performance Improvement (PI), Performance Improvement Quarterly (PIQ), TechTrends (TT).

Appendix B

Book Sample Selected for Analysis

Book Title	Author(s) or Editor(s)	Publication Year	*Frequency
Instructional design theories and models	Reigeluth, C. (Ed.)	1983	143
Instructional design theories and models	Reigeluth, C. (Ed.)	1999	128
Taxonomy of educational objectives, handbook I: The cognitive domain	Bloom, B. & Krathwohl, D.	1956	35
Interaction of Media Cognition and Learning	Salomon, G.	1979	34
The discovery of grounded theory	Glaser, B. & Strauss, A.	1967	30
Knowing, learning and instruction: Essays in honor of Robert Glaser	Resnick, L. (Ed.)	1989	28
Distributed cognitions	Salomon, G. (Ed.)	1993	28
Cognition, education, and multimedia	Nix, D. & Spiro, R. (Eds.)	1990	24
Educational psychology: A cognitive view	Ausubel, D.	1968	23
The mathematical theory of communication	Shannon, C., & Weaver, W.	1949	22
Social foundations of thought and action: A social cognitive theory	Bandura, A.	1986	20
Cognition and instruction	Klahr, D. (Ed.)	1976	20
Computers as cognitive tools	Lajoie, S. & Derry, S. (Eds.)	1993	20
CSCL: Theory and practice of an emerging paradigm	Koschmann, T. (Ed.)	1996	17
Everyday cognition	Rogoff, B. & Lave, J. (Eds.)	1984	17
Theoretical foundations of learning environments	Jonassen, D., & Land, S. (Eds.)	2000	16
Training complex cognitive skills	Van Merrienboer, J.	1997	16
Constructivism and the technology of instruction: A conversation	Duffy, T. & Jonassen, D.	1992	14
The architecture of cognition	Anderson, J.	1983	13
Toward a theory of instruction	Bruner, J.	1966	13
The conditions of learning and theory of instruction	Gagne, R.	1985	12

Book Title	Author(s) or Editor(s)	Publication Year	*Frequency
Cooperation and competition: Theory and research	Johnson, D. & Johnson, R.	1989	12
Everyday problem solving: Theory and application	Sinnot (Ed.)	1989	12
Self-regulated learning and academic achievement	Zimmerman, B. & Schunk, D. (Eds.)	1989	12
Social learning theory	Bandura, A.	1977	11
Metacognition in educational theory and practice	Dunlosky, H. & Graesser, A. (Eds.)	1998	11
Instructional message design: Principles from the behavioral and cognitive sciences	Fleming, M. & Levie, W. (Eds.)	1993	11
The cognitive psychology of school learning	Gagne, E.	1985	11
Handbook of learning and cognitive processes	Estes, W. (Ed.)	1978	11
Computers as cognitive tools	Lajoie, S. (Ed.)	2000	11
Cognition in practice	Lave, J.	1988	11
Cognitive and affective learning strategies	O'Neil, H. & Spielberger, C. (Eds.)	1979	11
Metacognition, motivation and understanding	Weinert, F. & Kluwe, R. (Eds.)	1987	11
Handbook of research on educational communications and technology	Jonassen, D. (Ed.)	1996	11
Instructional technology: Past, present, future	Anglin, G. (Ed.)	1991	10
Handbook of educational psychology	Berliner, D., & Calfee, R. (Eds.)	1996	10
Theories of Learning and Instruction	Hilgard, E. (Ed.)	1964	10
Cooperative learning: Theory, research and practice	Slavin, R.	1990	10
Handbook of research on educational communications and technology	Jonassen, D. (Ed.)	2004	n/a
Handbook of research on educational communications and technology	Spector, J., Merrill, M., van Merrienboer, J. & Driscoll, M. (Eds)	2008	n/a
Handbook of research on educational communications and technology	Spector, J., Merrill, M., Elen, J. & Bishop, M. (Eds.)	2014	n/a

Notes: Frequency is the number of times that the book was cited in ETRD between 1953 and 2012 with the keywords in the reference (cognitive, cognition, cognitivism, theory, theories) and in addition to a publication date.

Appendix C

Seminal Publications Selected for Analysis by Source

Book Title	Author(s) or Editor(s)	Publication Year	Number of Seminal Publications Cited
Handbook of educational psychology	Berliner, D., & Calfee, R. (Eds.)	1996	845
ETRD Articles	Various	Various	672
Handbook of research on educational communications and technology	Jonassen, D. (Ed.)	2004	641
Handbook of research on educational communications and technology	Spector, J., Merrill, M., van Merrienboer, J. & Driscoll, M. (Eds)	2008	634
Educational psychology: A cognitive view	Ausubel, D.	1968	463
Handbook of research on educational communications and technology	Jonassen, D. (Ed.)	1996	450
Social foundations of thought and action: A social cognitive theory	Bandura, A.	1986	417
Metacognition, motivation and understanding	Weinert, F. & Kluwe, R. (Eds.)	1987	274
Everyday problem solving: Theory and application	Sinnot (Ed.)	1989	170
Knowing, learning and instruction: Essays in honor of Robert Glaser	Resnick, L. (Ed.)	1989	166
The architecture of cognition	Anderson, J.	1983	155
Distributed cognitions	Salomon, G. (Ed.)	1993	128
Computers as cognitive tools	Lajoie, S. (Ed.)	2000	119

Book Title	Author(s) or Editor(s)	Publication Year	Number of Seminal Publications Cited
CSCL: Theory and practice of an emerging paradigm	Koschmann, T. (Ed.)	1996	117
Cognitive and affective learning strategies	O'Neil, H. & Spielberger, C. (Eds.)	1979	117
Computers as cognitive tools	Lajoie, S. & Derry, S. (Eds.)	1993	108
Handbook of research on educational communications and technology	Spector, J., Merrill, M., Elen, J. & Bishop, M. (Eds.)	2014	105
Cognition and instruction	Klahr, D. (Ed.)	1976	96
Interaction of Media Cognition and Learning	Salomon, G.	1979	91
Training complex cognitive skills	Van Merrienboer, J.	1997	76
Self-regulated learning and academic achievement	Zimmerman, B. & Schunk, D. (Eds.)	1989	67
Social learning theory	Bandura, A.	1977	61
Instructional technology: Past, present, future	Anglin, G. (Ed.)	1991	55
Instructional design theories and models	Reigeluth, C. (Ed.)	1999	46
Cognition, education, and multimedia	Nix, D. & Spiro, R. (Eds.)	1990	45
Metacognition in educational theory and practice	Dunlosky, H. & Graesser, A. (Eds.)	1998	41
Theoretical foundations of learning environments	Jonassen, D., & Land, S. (Eds.)	2000	30
Instructional message design: Principles from the behavioral and cognitive sciences	Fleming, M. & Levie, W. (Eds.)	1993	29
The cognitive psychology of school learning	Gagne, E.	1993	25
Everyday cognition	Rogoff, B. & Lave, J. (Eds.)	1984	24
Taxonomy of educational objectives, handbook I: The cognitive domain	Bloom, B. & Krathwohl, D.	1956	22
Cooperative learning: Theory, research and practice	Slavin, R.	1990	16
The conditions of learning and theory of instruction	Gagne, R.	1985	14
Instructional design theories and models	Reigeluth, C. (Ed.)	1983	12
Theories of Learning and Instruction	Hilgard, E. (Ed.)	1964	8
Handbook of learning and cognitive processes	Estes, W. (Ed.)	1978	4
Total Seminal Publications Captured for Analysis			6,343

Appendix D

Top 20 Seminal Publications Cited in ETRD by Citation Frequency (1953 – 2012)

No.	Seminal Publication	Sample Frequency	ETRD Frequency
1	Brown, J. S. Collins, A., & Duquid, P. (1989). Situated cognition and the culture of learning. Educational Researcher, 18, 32-42.	20	80
2	Miller, G. A. (1956). The magic number seven, plus or minus two: some limit of our capacity for processing information. Psychol. Rev., 63(2), 81–96.	12	26
3	Sweller, J., van Merreinboer, J., & Paas, F. (1998). Cognitive architecture and instructional design. Educational Psychology Review, 10(3), 251–296.	11	27
4	Salomon, G., Perkins , D. N. , & Globerson, T. (1991). Partners in cognition: Extending human intelligence with intelligent technologies. Educational Researcher, 20, I0-16.	11	14
5	Palincsar, A. M., & Brown, A. L. (1984). Reciprocal teaching of comprehension-fostering and monitoring activities. Cognition and Instruction, 1(2), 117-175.	10	19
6	Chandler, P. & Sweller, J. (1991). Cognitive load theory and the format of instruction. Cognition and Instruction 8, 293-332	9	9
7	Sweller, J. (1988). Cognitive load during problem solving: effects on learning. Cogn. Sci., 12, 257–285.	8	18
8	Flavell, J. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. American Psychologist, 34, 906- 911.	8	11
9	Spiro, R. J. Feltovich, P. J., Jacobson, M., & Coulson, R. L (1991). Cognitive flexibility, constructivism, and hypertext: Advanced knowledge acquisition in ill-structured domains. Educational Technology. 31(5) 24-33.	7	14
10	Shiffrin, R. M. and Schneider, W. (1977). Controlled and automatic human information processing. II. Perceptual learning, automatic attending, and a general theory. Psychol. Rev., 84, 127–190.	7	6
11	Pea, R. D. (1985). Beyond amplification: Using computers to reorganize human mental functioning. Educational Psychologist, 20, 167-82.	7	5
12	Brown A. L., Campione J. C., & Day J. D. (1981). "Learning to learn: On training students to learn from texts". Educational Researcher, 10, 14-21.	7	3
13	Scardamalia, M., Bereiter, C., McLean, R. S., Swallow, J., & Woodruff, E. (1989). Computer supported intentional learning environments. Journal of Educational Computing Research, 5, 51- 68.	6	16
14	Paas, F., Renkl, A., & Sweller, J. (2003). Cognitive load theory and instructional design: Recent developments. Educational Psychologist, 38(1), 1-4.	6	10
15	ANDERSON, J. R. (1978). Arguments concerning representations for mental imagery. Psychological Review, 85, 249-277.	6	4
16	Hannafin, M. J., & Rieber, L. E (1989). Psychological foundations of instructional design for emerging computer-based instructional technologies: Part 1. Educational Technology Research and Development, 37, 91-101.	5	15
17	Resnick, L. (1987). Learning in school and out. Educational Researcher, 16 (9), 3-21.	5	14
18	Salomon, G. & Perkins, D. (1989). Rocky roads to transfer: Rethinking mechanisms of a neglected phenomenon. Educational Psychologist, 24, 113-142.	5	8
19	Salomon, G. (1974). Internalization of filmic schematic operations in interaction with learners' aptitudes. Journal of Educational Psychology, 66, 499-511.	5	5
20	Sweller, J. and Cooper, G. A. (1985). The use of worked examples as a substitute for problem solving in learning algebra. Cogn. Instruct., 2, 59–89.	5	5

Appendix E

Number of References to Top 10 Seminal Publication Journals

	60 Years		Number of References and Rankings in the 15-Year Periods							
	Number	Rank	Number	Number	Number	Number	Rank	Rank	Rank	Rank
Description	1953 -2012	1953 -2012	1953 - 1967	1968 -1982	1983 -1997	1998 -2012	1953 -1967	1968 -1982	1983 -1997	1998 -2012
Educational Technology Research and Development	566	1	30	87	169	280	1	1	1	1
Journal of Educational Psychology	281	2	3	37	96	145	3	2	3	2
Review of Educational Research	237	3	-	35	122	80	17	3	2	5
Educational Psychologist	199	4	-	4	67	128	17	17	5	3
Educational Researcher	197	5	-	4	79	114	17	17	4	4
Cognitive Science	102	6	-	-	36	66	17	48	10	7
Psychological Review	97	7	1	22	37	37	5	4	8	12
Educational Technology	95	5	-	-	53	42	17	48	7	11
American Psychologist	87	9	1	19	37	30	5	6	8	13
Journal of the Learning Sciences	81	10	-	-	8	73	17	48	21	6
Total Top 10 Journals	1,942		35	208	704	995				
Total Other Journals	1,247		24	138	434	651				
Grand Total	3,189		59	346	1,138	1,646				

Notes: Educational Technology Research and Development includes Audio-Visual Communications, AV Communication, Educational Communications and Technology Journal and Educational Technology and Research Development. Adapted from Azar and Brock (2008), p. 789

Appendix F

Per Journal Impact of Seminal Publication Journals

	60 Years		Per Journal Impact and Rankings in the 15-Year Periods							
	Impact	Rank	Impact	Impact	Impact	Impact	Rank	Rank	Rank	Rank
Description	1953 -2012	1953 -2012	1953 - 1967	1968 -1982	1983 -1997	1998 -2012	1953 -1967	1968 -1982	1983 -1997	1998 -2012
Educational Technology Research and Development	17.7	1	50.8	25.1	14.9	17.0	1	1	1	1
Journal of Educational Psychology	8.8	2	5.1	10.7	8.4	8.8	3	2	3	2
Review of Educational Research	7.4	3	0.0	10.1	10.7	4.9	17	3	2	5
Educational Psychologist	6.2	4	0.0	1.2	5.9	7.8	17	17	5	3
Educational Researcher	6.2	5	0.0	1.2	6.9	6.9	17	17	4	4
Cognitive Science	3.2	6	0.0	0.0	3.2	4.0	17	48	10	7
Psychological Review	3.0	7	1.7	6.4	3.3	2.2	5	4	8	12
Educational Technology	3.0	5	0.0	0.0	4.7	2.6	17	48	7	11
American Psychologist	2.7	9	1.7	5.5	3.3	1.8	5	6	8	13
Journal of the Learning Sciences	2.5	10	0.0	0.0	0.7	4.4	17	48	21	6
Total Top 10 Journals	60.9		59.3	60.1	61.9	60.4				
Total Other Journals	39.1		40.7	39.9	38.1	39.6				
Grand Total	100.0		100.0	100.0	100.0	100.0				

Notes: Educational Technology Research and Development includes Audio-Visual Communications, AV Communication, Educational Communications and Technology Journal and Educational Technology and Research Development. Adapted from Azar and Brock (2008), p. 789

Appendix G

Number of Seminal Publication References in ETRD to Top 20 Sources

Source	All References		References to Journal Articles		References to Non-Journal Articles	
	Number	Rank	Number	Rank	Number	Rank
Various, ETRD Articles	1,539	1	895	1	644	1
Jonassen (2004), Handbook of research on educational communications and technology	877	2	448	2	429	2
Spector, Merrill, Merrienboer & Driscoll (2008) Handbook of research on educational communications and technology	840	3	434	3	406	4
Jonassen (1996), Handbook of research on educational communications and technology	785	4	366	4	418	3
Berliner & Calfee (1996), Handbook of educational psychology	571	5	242	5	329	5
Lajoie (2000), Computers as cognitive tools	184	6	95	6	88	7
Anglin (1991), Instructional technology: Past, present, future	151	7	20	21	131	6
Ausubel (1968), Educational psychology: A cognitive view	141	8	64	8	77	8
Merrienboer (1997), Training complex cognitive skills	133	9	62	9	72	11
Salomon (1979), Interaction of Media Cognition & Learning	123	10	67	7	56	13
Resnick (1989), Knowing, learning and instruction: Essays in honor of Robert Glaser	116	11	46	12	69	12
Koschmann (1996), CSCL: Theory and practice of an emerging paradigm	104	12	29	19	75	9
Bandura (1986), Social foundations of thought and action: A social cognitive theory	101	13	47	11	55	14
Salomon (1993), Distributed cognitions	97	14	25	20	72	10
Lajoie & Derry (1993), Computers as cognitive tools	92	15	39	15	53	15
Fleming & Levie (1993), Instructional message design: Principles from the behavioral and cognitive sciences	78	16	44	13	34	21
Jonassen & Land (2000), Theoretical foundations of learning environments	75	17	41	14	34	22
Spector, Merrill, Elen, & Bishop (2014), Handbook of research on educational communications and technology	74	18	56	10	18	26
Weinert & Kluwe (1987), Metacognition, motivation and understanding	69	19	30	17	39	19
O'Neil & Spielberger (1979), Cognitive and affective learning strategies	68	20	29	18	39	18
Total Top 20 Sources	6,217		3,079		3,138	
Total Other Sources	381		110		271	
Total	6,598		3,189		3,409	

Notes: ETRD includes Audio-Visual Communications, AV Communication, Educational Communications and Technology Journal and Educational Technology and Research Development. Adapted from Azar and Brock (2008), p. 789-790.

Appendix H

Per Source Impact of Seminal Publication Sources

	All References		References to Journal Articles		References to Non-Journal Articles	
Source	Impact	Rank	Impact	Rank	Impact	Rank
Various, ETRD Articles	23.3	1	28.1	1	18.9	1
Jonassen (2004), Handbook of research on educational communications and technology	13.3	2	14.0	2	12.6	2
Spector, Merrill, Merrienboer & Driscoll (2008) Handbook of research on educational communications and technology	12.7	3	13.6	3	11.9	4
Jonassen (1996), Handbook of research on educational communications and technology	11.9	4	11.5	4	12.3	3
Berliner & Calfee (1996), Handbook of educational psychology	8.7	5	7.6	5	9.7	5
Lajoie (2000), Computers as cognitive tools	2.8	6	3.0	6	2.6	7
Anglin (1991), Instructional technology: Past, present, future	2.3	7	0.6	21	3.9	6
Ausubel (1968), Educational psychology: A cognitive view	2.1	8	2.0	8	2.3	8
Merrienboer (1997), Training complex cognitive skills	2.0	9	1.9	9	2.1	11
Salomon (1979), Interaction of Media Cognition & Learning	1.9	10	2.1	7	1.7	13
Resnick (1989), Knowing, learning and instruction: Essays in honor of Robert Glaser	1.8	11	1.5	12	2.	12
Koschmann (1996), CSCL: Theory and practice of an emerging paradigm	1.6	12	0.9	19	2.2	9
Bandura (1986), Social foundations of thought and action: A social cognitive theory	1.5	13	1.5	11	1.6	14
Salomon (1993), Distributed cognitions	1.5	14	0.8	20	2.1	10
Lajoie & Derry (1993), Computers as cognitive tools	1.4	15	1.2	15	1.6	15
Fleming & Levie (1993), Instructional message design: Principles from the behavioral and cognitive sciences	1.2	16	1.4	13	1.0	21
Jonassen & Land (2000), Theoretical foundations of learning environments	1.1	17	1.3	14	1.0	22
Spector, Merrill, Elen, & Bishop (2014), Handbook of research on educational communications and technology	1.1	18	1.8	10	0.5	26
Weinert & Kluwe (1987), Metacognition, motivation and understanding	1.0	19	0.9	17	1.1	19
O'Neil & Spielberger (1979), Cognitive and affective learning strategies	1.0	20	0.9	18	1.2	18
Total Top 20 Sources	94.2		96.5		92.1	
Total Other Sources	5.8		3.5		7.9	
Total	100.0		100.0		100.0	

Notes: ETRD includes Audio-Visual Communications, AV Communication, Educational Communications and Technology Journal and Educational Technology and Research Development. Adapted from Azar and Brock (2008), p. 789-790.

Appendix I

ETRD Articles Citing the Sample Seminal Publications

Sample Seminal Publication	ETRD Articles Citing the Sample Seminal Publication
Brown, Collins & Duquid (1989)	Gagne, R. & Merrill, M. (1990). Integrative Goals for Instructional Design. *Educational Technology Research and Development, 38*(1),23-30.
Brown, Collins & Duquid (1989)	Tessmer, M., Wilson, B., & Driscoll, M. (1990). A New Model of Concept Teaching and Learning. *Educational Technology Research and Development, 38*(1),45-53.
Brown, Collins & Duquid (1989)	Wilson, B. & Cole, P. (1991). A Review of Cognitive Teaching Models. *Educational Technology Research and Development,* 39(4), 47-64.
Brown, Collins & Duquid (1989)	Hannafin, M. (1992). Emerging Technologies, ISD, and Learning Environments: Critical Perspectives. *Educational Technology Research and Development,* 40(1), 49-63.
Brown, Collins & Duquid (1989)	Cognition and Technology Group at Vanderbilt. (1992). The Jasper Experiment: An Exploration of Issues in Learning and Instructional Design. *Educational Technology Research and Development,* 40(1), 65-80.
Brown, Collins & Duquid (1989)	Rieber, L. (1992). Computer-Based Microworlds: A Bridge Between Constructivism and Direct Instruction. *Educational Technology Research and Development,* 40(1), 93-106.
Brown, Collins & Duquid (1989)	Tennyson, R., Elmore, R., & Snyder, L. (1992). Advancements in Instructional Design Theory: Contextual Module Analysis and Integrated Instructional Strategies. *Educational Technology Research and Development,* 40(2), 9-22.
Brown, Collins & Duquid (1989)	Wilson, B. & Cole, P. (1992). A Critical Review of Elaboration Theory. *Educational Technology Research and Development,* 40(3), 63-79.
Brown, Collins & Duquid (1989)	Fishman, B. & Duffy, T. (1992). Classroom Restructuring: What Do Teachers Really Need? *Educational Technology Research and Development,* 40(3), 95-111.
Brown, Collins & Duquid (1989)	Young, M. (1993). Instructional Design for Situated Learning. *Educational Technology Research and Development,* 41(1), 43-58.
Brown, Collins & Duquid (1989)	Orey, M. & Nelson, W. (1993). Development Principles for Intelligent Tutoring Systems: Integrating Cognitive Theory into the Development of Computer-Based Instruction. *Educational Technology Research and Development,* 41(1), 59-72.
Brown, Collins & Duquid (1989)	Lebow, D. (1993). Constructivist Values for Instructional Systems Design: Five Principles Toward a New Mindset. *Educational Technology Research and Development,* 41(3), 4-16.
Brown, Collins & Duquid (1989)	Park, I. & Hannafin, M. (1993). Empirically-Based Guidelines for the Design of Interactive Multimedia. *Educational Technology Research and Development,* 41(3), 63-85.
Brown, Collins & Duquid (1989)	Thurman, R. (1993). Instructional Simulation from a Cognitive Psychology Viewpoint. *Educational Technology Research and Development,* 41(4), 75-89.
Brown, Collins & Duquid (1989)	Jonassen, D., Campbell, J., & Davidson, M. (1994). Learning with Media: Restructuring the Debate. *Educational Technology Research and Development,* 42(2), 31-39.
Brown, Collins & Duquid (1989)	Quinn, J. (1994). Connecting Education and Practice in an Instructional Design Graduate Program. *Educational Technology Research and Development,* 42(3), 71-82.
Brown, Collins & Duquid (1989)	Dunn, T. (1994). If We Can't Contextualize It, Should We Teach It? *Educational Technology Research and Development,* 42(3), 83-92.

Sample Seminal Publication	ETRD Articles Citing the Sample Seminal Publication
Brown, Collins & Duquid (1989)	Kumar, D., Helgeson, S., & White, A. (1994). Computer Technology-Cognitive Psychology Interface and Science Performance Assessment. *Educational Technology Research and Development,* 42(4), 6-16.
Brown, Collins & Duquid (1989)	Dávila, J. & Keirns, J. (1994). The Effect of Co-Designing on Educational Transfer Between Cultures. *Educational Technology Research and Development,* 42(4), 89-100.
Brown, Collins & Duquid (1989)	Rieber, L. (1995). A Historical Review of Visualization in Human Cognition. *Educational Technology Research and Development,* 43(1), 45-56.
Brown, Collins & Duquid (1989)	Choi, J. & Hannafin, M. (1995). Situated Cognition and Learning Environments: Roles, Structures, and Implications for Design. *Educational Technology Research and Development,* 43(2), 53-69.
Brown, Collins & Duquid (1989)	Teslow, J. (1995). Humor Me: A Call for Research. *Educational Technology Research and Development,* 43(3), 6-28.
Brown, Collins & Duquid (1989)	Casey, C. (1996). Incorporating Cognitive Apprenticeship in Multi-Media. *Educational Technology Research and Development,* 44(1), 71-84.
Brown, Collins & Duquid (1989)	Rieber, L. (1996). Seriously Considering Play: Designing Interactive Learning Environments Based on the Blending of Microworlds, Simulations, and Games. *Educational Technology Research and Development,* 44(2), 43-58.
Brown, Collins & Duquid (1989)	Land, S. & Hannafin, M. (1996). A Conceptual Framework for the Development of Theories-in-Action with Open-Ended Learning Environments. *Educational Technology Research and Development,* 44(3), 37-53.
Brown, Collins & Duquid (1989)	Oliver, R. & Reeves, T. (1996). Dimensions of Effective Interactive Learning with Telematics for Distance Education. *Educational Technology Research and Development,* 44(4), 45-56.
Brown, Collins & Duquid (1989)	Land, S. &Hannafin, M. (1997). Patterns of Understanding with Open-ended Learning Environments: A Qualitative Study. *Educational Technology Research and Development,* 45(2), 47-73.
Brown, Collins & Duquid (1989)	Choi, J. & Hannafin, M. (1997). The Effects of Instructional Context and Reasoning Complexity on Mathematics Problem-Solving. *Educational Technology Research and Development,* 45(3), 43-55.
Brown, Collins & Duquid (1989)	Hannafin, M., Hannafin, K., Land, S., & Oliver, K. (1997). Grounded Practice and the Design of Constructivist Learning Environments. *Educational Technology Research and Development,* 45(3), 101-117.
Brown, Collins & Duquid (1989)	Laffey, J., Tupper, T., Musser, D., & Wedman, J. (1998). A Computer-Mediated Support System for Project-Based Learning. *Educational Technology Research and Development,* 46(1), 73-86.
Brown, Collins & Duquid (1989)	Moailem, M. (1998). An Expert Teacher's Thinking and Teaching and Instructional Design Models and Principles: An Ethnographic Study. *Educational Technology Research and Development,* 46(2), 37-64.
Brown, Collins & Duquid (1989)	Cobb, T. (1999). Applying Constructivism: A Test for the Learner-as-Scientist. *Educational Technology Research and Development,* 47(3), 15-31.
Brown, Collins & Duquid (1989)	Lin, X., Hmelo, C., Kinzer, C., & Secules, T. (1999). Designing Technology to Support Reflection. *Educational Technology Research and Development,* 47(3), 43-62.
Brown, Collins & Duquid (1989)	Bopry, J. (1999). The Warrant for Constructivist Practice Within Educational Technology. *Educational Technology Research and Development,* 47(4), 5-26.

Sample Seminal Publication	ETRD Articles Citing the Sample Seminal Publication
Brown, Collins & Duquid (1989)	Squire, K. & Johnson, C. (2000). Supporting Distributed Communities of Practice with Interactive Television. *Educational Technology Research and Development,* 48(1), 23-43.
Brown, Collins & Duquid (1989)	Barab, S., Squire, K., & Dueber, W. (2000). A Co-Evolutionary Model for Supporting the Emergence of Authenticity. *Educational Technology Research and Development,* 48(2), 37-62.
Brown, Collins & Duquid (1989)	Herrington, J. & Oliver, R. (2000). An Instructional Design Framework for Authentic Learning Environments. *Educational Technology Research and Development,* 48(3), 23-48.
Brown, Collins & Duquid (1989)	Land, S. (2000). Cognitive Requirements for Learning with Open-Ended Learning Environments. *Educational Technology Research and Development,* 48(3), 61-78.
Brown, Collins & Duquid (1989)	Brush, T. & Saye, J. (2000). Implementation and Evaluation of a Student-Centered Learning Unit: A Case Study. *Educational Technology Research and Development,* 48(3), 79-100.
Brown, Collins & Duquid (1989)	Shambaugh, N. & Magliaro, S. (2001). A Reflexive Model for Teaching Instructional Design. *Educational Technology Research and Development,* 49(2), 69-92.
Brown, Collins & Duquid (1989)	Nadolski, R., Kirscher, P., Van Merriënboer, J., & Hummel, H. (2001). A Model for Optimizing Step Size of Learning Tasks in Competency-based Multimedia Practicals. *Educational Technology Research and Development,* 49(3), 87-101.
Brown, Collins & Duquid (1989)	Oliver, K. & Hannafin, M. (2001). Developing and Refining Mental Models in Open-Ended Learning Environments: A Case Study. *Educational Technology Research and Development,* 49(4), 5-32.
Brown, Collins & Duquid (1989)	Howard, B., McGee, S., Shin, N., & Shia, R. (2001). The Triarchic Theory of Intelligence and Computer-Based Inquiry Learning. *Educational Technology Research and Development,* 49(4), 49-69.
Brown, Collins & Duquid (1989)	Barab, S., Makinster, J., Moore, J., Cunningham, D., & The ILF Design Team. (2001). Designing and Building an On-line Community: The Struggle to Support Sociability in the Inquiry Learning Forum. *Educational Technology Research and Development,* 49(4), 71-96.
Brown, Collins & Duquid (1989)	Heng, Y. & Sullivan, H. (2002). Student Performance and Attitudes Using Personalized Mathematics Instruction. *Educational Technology Research and Development,* 50(1), 21-34.
Brown, Collins & Duquid (1989)	Plass, J. & Salisbury, M. (2002). A Living-Systems Design Model for Web-based Knowledge Management Systems. *Educational Technology Research and Development,* 50(1), 35-56.
Brown, Collins & Duquid (1989)	Van Eck, R. & Dempsey, J. (2002). The Effect of Competition and Contextualized Advisement on the Transfer of Mathematics Skills in a Computer-Based Instructional Simulation Game. *Educational Technology Research and Development,* 50(3), 23-41.
Brown, Collins & Duquid (1989)	Saye, J. & Brush, T. (2002). Scaffolding Critical Reasoning About History and Social Issues in Multimedia-Supported Learning Environments. *Educational Technology Research and Development,* 50(3), 77-96.
Brown, Collins & Duquid (1989)	Seels, B., Campbell, S., & Talsma, V. (2003). Supporting Excellence in Technology Through Communities of Learners. *Educational Technology Research and Development,* 51(1), 91-104.
Brown, Collins & Duquid (1989)	Moallem, M. (2003). An Interactive Online Course: A Collaborative Design Model. *Educational Technology Research and Development,* 51(4), 85-103.
Brown, Collins & Duquid (1989)	Hannafin, R. (2004). Achievement Differences in Structured Versus Unstructured Instructional Geometry Programs. *Educational Technology Research and Development,* 52(1), 19-32.

Sample Seminal Publication	ETRD Articles Citing the Sample Seminal Publication
Brown, Collins & Duquid (1989)	Kirschner, P. (2004). Design, Development, and Implementation of Electronic Learning Environments for Collaborative Learning. *Educational Technology Research and Development,* 52(3), 39-46.
Brown, Collins & Duquid (1989)	Gulikers, J., Bastiaens, T., & Kirschner, P. (2004). A Five-Dimensional Framework for Authentic Assessment. *Educational Technology Research and Development,* 52(3), 67-86.
Brown, Collins & Duquid (1989)	Angeli, C. & Valanides, N. (2004). Examining the Effects of Text-Only and Text-and-Visual Instructional Materials on the Achievement of Field-Dependent and Field-Independent Learners During Problem-Solving with Modeling Software. *Educational Technology Research and Development,* 52(4), 23-36.
Brown, Collins & Duquid (1989)	Reeves, T., Herrington, J., & Oliver, R. (2004). A Development Research Agenda for Online Collaborative Learning. *Educational Technology Research and Development,* 52(4), 53-65.
Brown, Collins & Duquid (1989)	Darabi, A. (2005). Application of Cognitive Apprenticeship Model to a Graduate Course in Performance Systems Analysis: A Case Study. *Educational Technology Research and Development,* 53(1), 49-61.
Brown, Collins & Duquid (1989)	Dunlap, J. (2005). Problem-Based Learning and Self-Efficacy: How a Capstone Course Prepares Students for a Profession. *Educational Technology Research and Development,* 53(1), 65-83.
Brown, Collins & Duquid (1989)	Glazer, E., Hannafin, M., & Song, L. (2005). Promoting Technology Integration Through Collaborative Apprenticeship. *Educational Technology Research and Development,* 53(4), 57-67.
Brown, Collins & Duquid (1989)	Magliaro, S. & Shambaugh, N. (2006). Student Models of Instructional Design. *Educational Technology Research and Development,* 54(1), 83-106.
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Brown, Collins & Duquid (1989)	Kapur, M. & Kinzer, C. (2007). Examining the Effect of Problem Type in a Synchronous Computer-Supported Collaborative Learning (CSCL) Environment. *Educational Technology Research and Development,* 55(5), 439-459.
Brown, Collins & Duquid (1989)	Gerber, S. & Scott, L. (2007). Designing a Learning Curriculum and Technology's Role in it. *Educational Technlogy Research and Development,* 55(5), 461-478.
Brown, Collins & Duquid (1989)	Kopcha, T. & Sullivan, H. (2007). Self-Presentation Bias in Surveys of Teachers' Educational Technology Practices. *Educational Technology Research and Development,* 55(6), 627-646.
Brown, Collins & Duquid (1989)	Kim, H. & Hannafin, M. (2008). Grounded Design of Web-Enhanced Case-Based Activity. *Educational Technology Research and Development,* 56(2), 161-179.
Brown, Collins & Duquid (1989)	Johari, A. & Bradshaw, A. (2008). Project-Based Learning in an Internship Program: A Qualitative Study of Related Roles and Their Motivational Attributes. *Educational Technology Research and Development,* 56(3), 329-359.
Brown, Collins & Duquid (1989)	Nelson, B. & Erlandson, B. (2008). Managing Cognitive Load in Educational Multi-User Virtual Environments: Reflection on Design Practice. *Educational Technology Research and Development,* 56(5), 619-641.

Sample Seminal Publication	ETRD Articles Citing the Sample Seminal Publication
Brown, Collins & Duquid (1989)	Larson, M. & Lockee, B. (2009). Preparing Instructional Designers for Different Career Environments: A Case Study. *Educational Technology Research and Development,* 57(1), 1-24.
Brown, Collins & Duquid (1989)	Woolf, N. & Quinn, J. (2009). Learners' Perceptions of Instructional Design Practice in a Situated Learning Activity. *Educational Technology Research and Development,* 57(1), 25-43.
Brown, Collins & Duquid (1989)	West, R. (2009). What is Shared? A Framework for Understanding Shared Innovation within Communities. *Educational Technology Research and Development,* 57(3), 315-332.
Brown, Collins & Duquid (1989)	Hong, H. & Sullivan, F. (2009). Towards an Idea-Centered, Principle-Based Design Approach to Support Learning as Knowledge Creation. *Educational Technology Research and Development,* 57(5), 613-627.
Brown, Collins & Duquid (1989)	Kopcha, T. (2010). A Systems-Based Approach to Technology Integration Using Mentoring and Communities of Practice. *Educational Technology Research and Development,* 58(2), 175-190.
Brown, Collins & Duquid (1989)	McCrary, N. & Mazur, J. (2010). Conceptualizing a Narrative Simulation to Promote Dialogic Reflection: Using a Multiple Outcome Design to Engage Teacher Mentors. *Educational Technology Research and Development,* 58(3), 325-342.
Brown, Collins & Duquid (1989)	Clinton, G. & Rieber, L. (2010). The Studio Experience at the University of Georgia: An Example of Constructionist Learning for Adults. *Educational Technology Research and Development,* 58(6), 755-780.
Brown, Collins & Duquid (1989)	Dickey, M. (2011). The Pragmatics of Virtual Worlds for K-12 Educators: Investigating the Affordances and Constraints of Active Worlds and Second Life with K-12 in-Service Teachers. *Educational Technology Research and Development,* 59(1), 1-20.
Brown, Collins & Duquid (1989)	Jonassen, D. (2011). Ask Systems: Interrogative Access to Multiple Ways of Thinking. *Educational Technology Research and Development,* 59(1), 159-175.
Brown, Collins & Duquid (1989)	Sullivan, F., Hamilton, C., Allessio, D., Boit, R., Deschamps, A., Sindelar, T., Ramos, G., Randall, A., Wilson, N., & Yan, Z. (2011). Representational Guidance and Student Engagement: Examining Designs for Collaboration in Online Synchronous Environments. *Educational Technology Research and Development, 59(5), 619-644.*
Brown, Collins & Duquid (1989)	Xiaoli, Z. & Bishop, M. (2011). Understanding and Supporting Online Communities of Practice: Lessons Learned from Wikipedia. *Educational Technology Research and Development,* 59(5), 711-735.
Brown, Collins & Duquid (1989)	Lubin, I. & Xun, G. (2012). Investigating the Influences of a LEAPS Model on Preservice Teachers' Problem Solving, Metacognition, and Motivation in an Educational Technology Course. *Educational Technology Research and Development,* 60(2), 239-270.
Brown, Collins & Duquid (1989)	Oshima, J., Oshima, R., & Yoshiaki, M. (2012). Knowledge Building Discourse Explorer: A Social Network Analysis Application for Knowledge Building Discourse. *Educational Technology Research and Development,* 60(5), 903-921.
Miller (1956)	Hsia, H. (1968). On Channel Effectiveness. *Educational Technology Research and Development,* 16(3), 245-267.
Miller (1956)	Hsia, H. (1971). The Information Processing Capacity of Modality and Channel Performance. *Educational Technology Research and Development,* 19(1), 51-75.
Miller (1956)	Randhawa, B. (1971). Intellectual Development and the Ability to Process Visual and Verbal Information. *Educational Technology Research and Development,* 19(3), 298-312.

Sample Seminal Publication	ETRD Articles Citing the Sample Seminal Publication
Miller (1956)	Rossiter Jr, C. (1971). Rate-of-Presentation Effects on Recall of Facts and of Ideas and on Generation of Inferences. *Educational Technology Research and Development,* 19(3), 313-324.
Miller (1956)	Cunningham, D. (1971). Task Analysis and Part Versus Whole Learning Methods. *Educational Technology Research and Development,* 19(4), 365-398.
Miller (1956)	Grover Jr, P. (1974). Effect of Varied Stimulus Complexity and Duration upon Immediate Recall of Visual Material in a Serial Learning Task. *Educational Technology Research and Development,* 22(4), 439-452.
Miller (1956)	Goldstein, E. (1975). The Perception of Multiple Images. *Educational Technology Research and Development,* 23(1), 34-68.
Miller (1956)	Dwyer, F. (1976). The Effect of IQ Level on the Instructional Effectiveness of Black-and-White and Color Illustrations. *Educational Technology Research and Development,* 24(1), 49-62.
Miller (1956)	Bovy, R. (1981). Successful Instructional Methods: A Cognitive Information Processing Approach. *Educational Technology Research and Development,* 29(4), 203-217.
Miller (1956)	Schmid, R. & Gerlach, V. (1986). An Analysis of Algorithmic Processes and Instructional Design. *Educational Technology Research and Development,* 34(3), 163-174.
Miller (1956)	Hannafin, M. & Rieber, L. (1989). Psychological Foundations of Instructional Design for Emerging Computer-Based Instructional Technologies: Part 1. *Educational Technology Research and Development,* 37(2), 91-101.
Miller (1956)	Zhongmin, L. & Merrill, M. (1991). ID Expert 2.0: Design Theory and Process. *Educational Technology Research and Development,* 39(2), 53-69.
Miller (1956)	Hueyching, J. & Reeves, T. (1992). Mental Models: A Research Focus for Interactive Learning Systems. *Educational Technology Research and Development,* 40(3), 39-53.
Miller (1956)	Cates, W. & Goodling, S. (1997). The Relative Effectiveness of Learning Options in Multimedia Computer-Based Fifth-Grade Spelling Instruction. *Educational Technology Research and Development,* 45(2), 27-46.
Miller (1956)	Cobb, T. (1997). Cognitive Efficiency: Toward a Revised Theory of Media. *Educational Technology Research and Development,* 45(4), 21-35.
Miller (1956)	Rittschof, K. & Kulhavy, R. (1998). Learning and Remembering from Thematic Maps of Familiar Regions. *Educational Technology Research and Development,* 46(1), 19-38.
Miller (1956)	Silber, K. (1998). The Cognitive Approach to Training Development: A Practitioner's Assessment. *Educational Technology Research and Development,* 46(4), 58-72.
Miller (1956)	Van Merrienboer, J. & Ayres, P. (2005). Research on Cognitive Load Theory and Its Design Implications for E-Learning. *Educational Technology Research and Development,* 53(3), 5-13.
Miller (1956)	Clarke, T., Ayres, P., & Sweller, J. (2005). The Impact of Sequencing and Prior Knowledge on Learning Mathematics Through Spreadsheet Applications. *Educational Technology Research and Development,* 53(3), 15-24.
Miller (1956)	Kalyuga, S. & Sweller, J. (2005). Rapid Dynamic Assessment of Expertise to Improve the Efficiency of Adaptive E-learning. *Educational Technology Research and Development,* 53(3), 83-93.
Miller (1956)	Pociask, F. & Morrison, G. (2008). Controlling Split Attention and Redundancy in Physical Therapy Instruction. *Educational Technology Research and Development,* 56(4), 379-399.

Sample Seminal Publication	ETRD Articles Citing the Sample Seminal Publication
Miller (1956)	Fadde, P. (2009). Instructional Design for Advanced Learners: Training Recognition Skills to Hasten Expertise. *Educational Technology Research and Development,* 57(3), 359-376.
Miller (1956)	Huang-Yao, H. & Sullivan, F. (2009). Towards an Idea-Centered, Principle-Based Design Approach to Support Learning as Knowledge Creation. *Educational Technology Research and Development,* 57(5), 613-627.
Miller (1956)	Rittschof, K. (2010). Field Dependence–Independence as Visuospatial and Executive Functioning in Working Memory: Implications for Instructional Systems Design and Research. *Educational Technology Research and Development,* 58(1), 99-114.
Miller (1956)	Pastore, R. (2010). The Effects of Diagrams and Time-Compressed Instruction on Learning and Learners' Perceptions of Cognitive Load. *Educational Technology Research and Development,* 58(5), 485-505.
Miller (1956)	Leslie, K., Low, R., Putai, J., & Sweller, J. (2012). Redundancy and Expertise Reversal Effects when Using Educational Technology to Learn Primary School Science. *Educational Technology Research and Development,* 60(1), 1-13.
Palincsar & Brown (1984)	Wilson, B. & Cole, P. (1991). A Review of Cognitive Teaching Models. *Educational Technology Research and Development,* 39(4), 47-64.
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Palincsar & Brown (1984)	Land, S. & Hannafin, M. (1996). A Conceptual Framework for the Development of Theories-in-Action with Open-Ended Learning Environments. *Educational Technology Research and Development,* 44(3), 37-53.
Palincsar & Brown (1984)	Hannafin, M., Hannafin, K., Land, S., & Oliver, K. (1997). Grounded Practice and the Design of Constructivist Learning Environments. *Educational Technology Research and Development,* 45(3), 101-117.
Palincsar & Brown (1984)	Xiaodong, L., Hmelo, C., Kinzer, C., & Secules, T. (1999). Designing Technology to Support Reflection. *Educational Technology Research and Development,* 47(3), 43-62.
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Palincsar & Brown (1984)	Brush, T. & Saye, J. (2000). Implementation and Evaluation of a Student-Centered Learning Unit: A Case Study. *Educational Technology Research and Development,* 48(3), 79-100.
Palincsar & Brown (1984)	Nath, L. & Ross, S. (2001). The Influence of a Peer-Tutoring Training Model for Implementing Cooperative Groupings with Elementary Students. *Educational Technology Research and Development,* 49(2), 41-56.
Palincsar & Brown (1984)	Saye, J. & Brush, T. (2002). Scaffolding Critical Reasoning About History and Social Issues in Multimedia-Supported Learning Environments. *Educational Technology Research and Development,* 50(3), 77-96.
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Sample Seminal Publication	ETRD Articles Citing the Sample Seminal Publication
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Palincsar & Brown (1984)	Manu, K. & Kinzer, C. (2007). Examining the Effect of Problem Type in a Synchronous Computer-Supported Collaborative Learning (CSCL) Environment. *Educational Technology Research and Development,* 55(5), 439-459.
Palincsar & Brown (1984)	Shapiro, A. (2008). Hypermedia Design as Learner Scaffolding. *Educational Technology Research and Development,* 56(1), 29-44.
Palincsar & Brown (1984)	Johari, A. & Bradshaw, A. (2008). Project-Based Learning in an Internship Program: A Qualitative Study of Related Roles and Their Motivational Attributes. *Educational Technology Research and Development,* 56(3), 329-359.
Palincsar & Brown (1984)	Bottge, B., Rueda, E., Jung, K., Grant, T., & LaRaque, P. (2009). Assessing and Tracking Students' Problem Solving Performances in Anchored Learning Environments. *Educational Technology Research and Development,* 57(4), 529-552.
Palincsar & Brown (1984)	Bulu, S. & Pedersen, S. (2010). Scaffolding Middle School Students' Content Knowledge and Ill-Structured Problem Solving in a Problem-Based Hypermedia Learning Environment. *Educational Technology Research and Development,* 58(5), 507-529.
Palincsar & Brown (1984)	Chin, D., Dohmen, I., Cheng, B., Oppezzo, M., Chase, C., & Schwarts, D. (2010). Preparing Students for Future Learning with Teachable Agents. *Educational Technology Research and Development,* 58(6), 649-669.
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Salomon, Perkins, & Globerson (1991)	Kozma, R. (1994). Will Media Influence Learning? Reframing the Debate. *Educational Technology Research and Development,* 42(2), 7-19.
Salomon, Perkins, & Globerson (1991)	Clark, R. (1994). Media Will Never Influence Learning. *Educational Technology Research and Development,* 42(2), 21-29.
Salomon, Perkins, & Globerson (1991)	Jonassen, D., Campbell, J., & Davidson, M. (1994). Learning with Media: Restructuring the Debate. *Educational Technology Research and Development,* 42(2), 31-39.
Salomon, Perkins, & Globerson (1991)	Kozma, R. (1994). A Reply: Media and Methods. *Educational Technology Research and Development,* 42(3), 11-14.

Sample Seminal Publication	ETRD Articles Citing the Sample Seminal Publication
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Salomon, Perkins, & Globerson (1991)	Land, S. & Hannafin, M. (1996). A Conceptual Framework for the Development of Theories-in-Action with Open-Ended Learning Environments. *Educational Technology Research and Development,* 44(3), 37-53.
Salomon, Perkins, & Globerson (1991)	Barab, S., Bowdish, B., & Lawless, K. (1997). Hypermedia Navigation: Profiles of Hypermedia Users. *Educational Technology Research and Development,* 45(3), 23-41.
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Salomon, Perkins, & Globerson (1991)	Min, L. & Bera, S. (2005). An Analysis of Cognitive Tool Use Patterns in a Hypermedia Learning Environment. *Educational Technology Research and Development,* 53(1), 5-21.
Salomon, Perkins, & Globerson (1991)	Judson, E. (2010). Improving Technology Literacy: Does it Open Doors to Traditional Content? *Educational Technology Research and Development,* 58(3), 271-284.
Salomon, Perkins, & Globerson (1991)	Bulu, S. & Pedersen, S. (2010). Scaffolding Middle School Students' Content Knowledge and ill-Structured Problem Solving in a Problem-Based Hypermedia Learning Environment. *Educational Technology Research and Development,* 58(5), 507-529.
Salomon, Perkins, & Globerson (1991)	Zacharia, Z., Xenofontos, N., & Manoli, C. (2011). The Effect of two Different Cooperative Approaches on Students' Learning and Practices within the Context of a WebQuest Science Investigation. *Educational Technology Research and Development,* 59(3), 399-424.
Sweller, Merreinboer & Paas (1998)	Nadolski, R., Kirschner, P., Van Merrienboer, J., & Hummel, H. (2001). A Model for Optimizing Step Size of Learning Tasks in Competency-based Multimedia Practicals. *Educational Technology Research and Development,* 49(3), 87-101.
Sweller, Merreinboer & Paas (1998)	Baylor, A. (2002). Expanding Preservice Teachers' Metacognitive Awareness of Instructional Planning Through Pedagogical Agents. *Educational Technology Research and Development,* 50(2), 5-22.
Sweller, Merreinboer & Paas (1998)	Van Merriemboer, J., Clark, R., & De Croock, M. (2002). Blueprints for Complex Learning: The 4C/ID-Model. *Educational Technology Research and Development,* 50(2), 39-61.

Sample Seminal Publication	ETRD Articles Citing the Sample Seminal Publication
Sweller, Merreinboer & Paas (1998)	De Croock, M., Paas, F., Schlanbusch, H., & Van Merrienboer, J. (2002). ADAPTIT: Tools for Training Design and Evaluation. *Educational Technology Research and Development,* 50(4), 47-58.
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Sweller, Merreinboer & Paas (1998)	Van Merrienboer, J. & Ayres, P. (2005). Research on Cognitive Load Theory and Its Design Implications for E-Learning. *Educational Technology Research and Development,* 53(3), 5-13.
Sweller, Merreinboer & Paas (1998)	Clarke, T., Ayres, P., & Sweller, J. (2005). The Impact of Sequencing and Prior Knowledge on Learning Mathematics Through Spreadsheet Applications. *Educational Technology Research and Development,* 53(3), 15-24.
Sweller, Merreinboer & Paas (1998)	Paas, F., Tuovinen, J., Van Merrienboer, J., & Darabi, A. (2005). A Motivational Perspective on the Relation Between Mental Effort and Performance: Optimizing Learner Involvement in Instruction. *Educational Technology Research and Development,* 53(3), 25-34.
Sweller, Merreinboer & Paas (1998)	Moreno, R. & Valdez, A. (2005). Cognitive Load and Learning Effects of Having Students Organize Pictures and Words in Multimedia Environments: The Role of Student Interactivity and Feedback. *Educational Technology Research and Development,* 53(3), 35-45.
Sweller, Merreinboer & Paas (1998)	Schnotz, W. & Rasch, T. (2005). Enabling, Facilitating, and Inhibiting Effects of Animations in Multimedia Learning: Why Reduction of Cognitive Load Can Have Negative Results on Learning. *Educational Technology Research and Development,* 53(3), 47-58.
Sweller, Merreinboer & Paas (1998)	Wallen, E., Plass, J., & Brunken, R. (2005). The Function of Annotations in the Comprehension of Scientific Texts: Cognitive Load Effects and the Impact of Verbal Ability. *Educational Technology Research and Development,* 53(3), 59-71.
Sweller, Merreinboer & Paas (1998)	Van Gog, T., Ericsson, K., Rikers, R., & Paas, F. (2005). Instructional Design for Advanced Learners: Establishing Connections Between the Theoretical Frameworks of Cognitive Load and Deliberate Practice. *Educational Technology Research and Development,* 53(3), 73-81.
Sweller, Merreinboer & Paas (1998)	Morrison, G. & Anglin, G. (2005). Research on Cognitive Load Theory: Application to E-Learning. *Educational Technology Research and Development,* 53(3), 94-104.
Sweller, Merreinboer & Paas (1998)	Lohr, L. (2006). Book Reviews. *Educational Technology Research and Development,* 54(4), 417-420.
Sweller, Merreinboer & Paas (1998)	Stoof, A., Martens, R., & Van Merrienboer, J. (2007). Web-Based Support for Constructing Competence Maps: Design and Formative Evaluation. *Educational Technology Research and Development,* 55(4), 347-368.
Sweller, Merreinboer & Paas (1998)	Boot, E., Van Merrienboer, J., & Veerman, A. (2007). Novice and Experienced Instructional Software Developers: Effects on Materials Created with Instructional Software Templates. *Educational Technology Research and Development,* 55(6), 647-666.
Sweller, Merreinboer & Paas (1998)	Gerjets, P., Scheiter, K., & Schuh, J. (2008). Information Comparisons in Example-Based Hypermedia Environments: Supporting Learners with Processing Prompts and an Interactive Comparison Tool. *Educational Technology Research and Development,* 56(1), 73-92.

Sample Seminal Publication	ETRD Articles Citing the Sample Seminal Publication
Sweller, Merreinboer & Paas (1998)	Beers, P., Boshuizen, H., Kirschner, P., Gijselaers, W., & Westendorp, J. (2008). Cognitive Load Measurements and Stimulated Recall Interviews for Studying the Effects of Information and Communications Technology. *Educational Technology Research and Development,* 56(3), 309-328.
Sweller, Merreinboer & Paas (1998)	Pociask, F. & Morrison, G. (2008). Controlling Split Attention and Redundancy in Physical Therapy Instruction. *Educational Technology Research and Development,* 56(4), 379-399.
Sweller, Merreinboer & Paas (1998)	Kay, R. & Knaack, L. (2009). Assessing Learning, Quality and Engagement in Learning Objects: The Learning Object Evaluation Scale for Students (LOES-S). *Educational Technology Research and Development,* 57(2), 147-168.
Sweller, Merreinboer & Paas (1998)	Hannifin, M., Hannafin, K., & Gabbitas, B. (2009). Re-Examining Cognition During Student-Centered, Web-Based Learning. *Educational Technology Research and Development,* 57(6), 767-785.
Sweller, Merreinboer & Paas (1998)	Van Gog, T., Sluijsmans, D., Brinke, D., & Prins, F. (2010). Formative Assessment in an Online Learning Environment to Support Flexible On-the-job Learning in Complex Professional Domains. *Educational Technology Research and Development,* 58(3), 311-324.
Sweller, Merreinboer & Paas (1998)	Pastore, R. (2010). The Effects of Diagrams and Time-Compressed Instruction on Learning and Learners' Perceptions of Cognitive Load. *Educational Technology Research and Development,* 58(5), 485-505.
Sweller, Merreinboer & Paas (1998)	York, C. & Ertmer, P. (2011). Towards an Understanding of Instructional Design Heuristics: An Exploratory Delphi Study. *Educational Technology Research and Development,* 59(6), 841-863.
Sweller, Merreinboer & Paas (1998)	Noroozi, O., Busstra, M., Mulder, M., Biemans, H., Tobi, H., Geelen, A., Van't Veer, P., & Chizari, M. (2012). Online Discussion Compensates for Suboptimal Timing of Supportive Information Presentation in a Digitally Supported Learning Environment. *Educational Technology Research and Development,* 60(2), 193-221.
Sweller, Merreinboer & Paas (1998)	Fiorella, L., Vogel-Walcutt, J., & Schatz, S. (2012). Applying the Modality Principle to Real-Time Feedback and the Acquisition of Higher-Order Cognitive Skills. *Educational Technology Research and Development,* 60(2), 223-238.
Sweller, Merreinboer & Paas (1998)	Cheon, J. & Grant, M. (2012). The Effects of Metaphorical Interface on Germane Cognitive Load in Web-based Instruction. *Educational Technology Research and Development,* 60(3), 399-420.

Appendix J

Citation Contexts Linking the Sample Seminal Publications to ETRD

Sample Seminal Publication	Citing ETRD Article	Citation Context
Brown, Collins & Duquid (1989)	Cognition and Technology Group at Vanderbilt. (1992). The Jasper Experiment: An Exploration of Issues in Learning and Instructional Design. Educational Technology Research and Development, 40(1), 65-80.	Real apprenticeships provide a contrast to the oversimplified materials used in many curricula (e.g., see Brown et al., 1989).
Brown, Collins & Duquid (1989)	Cognition and Technology Group at Vanderbilt. (1992). The Jasper Experiment: An Exploration of Issues in Learning and Instructional Design. Educational Technology Research and Development, 40(1), 65-80.	In order to encourage generative learning, CTGV emphasizes the benefits of anchoring or situating instruction in meaningful problem solving contexts that allow one to simulate in the classroom some of the advantages of apprenticeship learning (e.g., Brown et al., 1989; CTGV, 1990, 1991a).
Brown, Collins & Duquid (1989)	Cognition and Technology Group at Vanderbilt. (1992). The Jasper Experiment: An Exploration of Issues in Learning and Instructional Design. Educational Technology Research and Development, 40(1), 65-80.	On the three dimensions of content sequencing, feedback, and the role of the teacher, the decontextualized "basics first" model of teaching stands in direct contrast to the anchored instruction approach described earlier in this article and elsewhere (e.g., CTGV, 1990; see also Brown et al., 1989)
Brown, Collins & Duquid (1989)	Cognition and Technology Group at Vanderbilt. (1992). The Jasper Experiment: An Exploration of Issues in Learning and Instructional Design. Educational Technology Research and Development, 40(1), 65-80.	The goal of this article is to discuss one approach to instructional design, called "anchored" instruction, whereby instruction is situated in engaging, problem-rich environments that allow sustained exploration by students and teachers. In the process, they come to understand why, when, and how to use various concepts and strategies (e.g., Brown, Collins, & Duguid, 1989; Cognition & Technology Group at Vanderbflt [CTGV], 1990).
Brown, Collins & Duquid (1989)	Angeli, C. & Valanides, N. (2004). Examining the Effects of Text-Only and Text-and-Visual Instructional Materials on the Achievement of Field-Dependent and Field-Independent Learners During Problem-Solving with Modeling Software. Educational Technology Research and Development, 52(4), 23-36.	Siding with this view, Brown, Collins, and Duguid (1989) stated that knowledge is not objective but contextually situated, and is fundamentally influenced by the activity, context, and culture in which it is used.
Brown, Collins & Duquid (1989)	Barab, S., Makinster, J., Moore, J., Cunningham, D., & The ILF Design Team. (2001). Designing and Building an On-line Community: The Struggle to Support Sociability in the Inquiry Learning Forum. Educational Technology Research and Development, 49(4), 71-96.	A central assumption to many of the interpretations of situated cognition is the mutual relation of content and context, of individual and environment, and of knowing and doing, and the conviction that learning is always situated and progressively developed through activity (Barab et al., 1999; Brown, Collins, & Duguid, 1989; Lave, 1988; Lave & Wenger, 1991; Young, 1993).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Brown, Collins & Duquid (1989)	Bopry, J. (1999). The Warrant for Constructivist Practice Within Educational Technology. Educational Technology Research and Development, 47(4), 5-26.	These three levels of experience (nonreflective activity, observation, description) are roughly parallel to Bereiter's (1994) description of Popper's three worlds (physical mental, immaterial objects); Brown, Collins, and Duguid's (1989) organizer (activity, concept, culture); and Varela et al.'s (1991) levels (biology, psychology, culture).
Brown, Collins & Duquid (1989)	Bopry, J. (1999). The Warrant for Constructivist Practice Within Educational Technology. Educational Technology Research and Development, 47(4), 5-26.	Like any living organism, learners are structurally coupled to their environment. Learners engage in structural coupling to create social groupings. Through structural coupling, reflexivity makes social consensus possible. Effective action is a process whereby a learner is able to maintain an ongoing interaction with some other, and through this interaction enter into a shared world of meaning. This involves two separate abilities: (a) keeping a conversation going (avoiding problems), and (b) bringing it back on course when an obstacle or problem arises (problem solving). While cognitive constructivists may tend to focus on the latter, social constructivists remind us of the importance of the former. When we consider the ability to avoid problems, it becomes apparent why social constructivists speak about enculturation (e.g., Brown, et al., 1989).
Brown, Collins & Duquid (1989)	Brush, T. & Saye, J. (2000). Implementation and Evaluation of a Student-Centered Learning Unit: A Case Study. Educational Technology Research and Development, 48(3), 79-100.	There are numerous examples and strategies for implementing student-centered learning, including situated cognition and cognitive apprenticeship (Brown et al., 1989; Choi & Hannafin, 1995), anchored instruction and macrocontexts (Cognition and Technology Group at Vanderbilt [CTGV], 1992, 1993; Young, 1993), problem-based learning (Savery & Duffy, 1995; Scott & Brush, 1998), and open-ended learning environments (Hannafin et al., 1999; Hannafin & Land, 1997).
Brown, Collins & Duquid (1989)	Brush, T. & Saye, J. (2000). Implementation and Evaluation of a Student-Centered Learning Unit: A Case Study. Educational Technology Research and Development, 48(3), 79-100.	Thus student-centered learning activities would engage students in challenging, real-life tasks, with technology as a tool for learning, communication, and collaboration. These activities would provide students with opportunities to view problems from a variety of perspectives, allow students to collaborate and negotiate solutions to problems, and test those solutions within a real-world context (Bednar et al., 1992; Brown, Collins, & Duguid, 1989; Duffy & Jonassen, 1991).
Brown, Collins & Duquid (1989)	Casey, C. (1996). Incorporating Cognitive Apprenticeship in Multi-Media. Educational Technology Research and Development, 44(1), 71-84.	Issues facing designers of instructional multimedia are numerous and profound: an audience that is often not part of a communityofpractice (Brown, & Duguid, 1991) where learning occurs in a communal environment of discussion, analysis, and reflection; a diverse audience having varying levels of subject-matter expertise, metacognitive skills, manmachine interface skills, and motivation; an ill-structured subject matter; and problematic learning environments.
Brown, Collins & Duquid (1989)	Casey, C. (1996). Incorporating Cognitive Apprenticeship in Multi-Media. Educational Technology Research and Development, 44(1), 71-84.	The case for situating instruction has been suggested (Bransford, Sherwood, Hasselbring, Kinzer & Williams 1990; Brown, Collins & Duguid, 1989; The Cognition and Technology Group, 1990; Resnick, 1988).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Brown, Collins & Duquid (1989)	Casey, C. (1996). Incorporating Cognitive Apprenticeship in Multi-Media. Educational Technology Research and Development, 44(1), 71-84.	Two subjectmatter experts, who are introduced early in the course, set the tone and context, and pro· vide guidance throughout. As learners perform a variety of forecasting tasks, such as analyzing data, identifying features in Doppler radar imagery, and predicting future condi· tions, they have the option of receiving explanations about their activities by selecting EXPERT ANSWER. The expert explains the process used to solve the case. During these explanations imagery is accessed from videodisc; graphic overlays highlight specific features; and segments from the conceptual models or tutorials are referenced. Sometimes a production technique called chroma-key is used that allows the expert to appear in front of the imagery and point to specific features, similar to a television weatherman. Experts verbalize the processes they used when they attempted to solve the case. On some occasions initial solutions resulted in erroneous forecasts. Experts use these special cases to highlight their own false starts and dead-ends and to discuss caveats when dealing with unstable subject matter. 77 coaching. "Coaching consists of observing students while they carry out a task and offering hints, scaffolding, feedback, modeling, reminders, and new tasks aimed at bringing their performance closer to expert performance" (Brown, Collins & DuguicJ., 1989).
Brown, Collins & Duquid (1989)	Choi, J. & Hannafin, M. (1995). Situated Cognition and Learning Environments: Roles, Structures, and Implications for Design. Educational Technology Research and Development, 43(2), 53-69.	In order for students to develop the skills used by experts, they need to engage in similar cognitive activities-- authentic tasks in authentic contexts. Authentic tasks are coherent, meaningful, and purposeful activities that represent the ordinary practices of a culture (Brown et al., 1989).
Brown, Collins & Duquid (1989)	Choi, J. & Hannafin, M. (1995). Situated Cognition and Learning Environments: Roles, Structures, and Implications for Design. Educational Technology Research and Development, 43(2), 53-69.	Brown et al. also suggest that meaning is not universal, but is influenced heavily by cultural factors: "The community and its viewpoint determine how [knowledge] is used (p. 33)." For example, carpenters and cabinet makers use chisels differently; physicists use mathematics differently from engineers. Appropriate use of tools is not engendered simply by knowing about the abstract concepts, but is a function of the culture and the activities within which the tool evolves. It is unlikely, therefore, that tools will be used appropriately without an understanding of the culture of their use. Several parallels to formal education practice are apparent. Often, students are asked to use mathematics without knowing how practitioners use the knowledge of their domains, science concepts without the benefit of seeing how scientists employ them, and historical information without the framing provided by historians. Their content knowledge, as a consequence, lacks contextual anchors that help to define its meaning.
Brown, Collins & Duquid (1989)	Choi, J. & Hannafin, M. (1995). Situated Cognition and Learning Environments: Roles, Structures, and Implications for Design. Educational Technology Research and Development, 43(2), 53-69.	In informal learning contexts, on the other hand, individuals apply knowledge practically and routinely to solve everyday problems (Brown, et al., 1989).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Brown, Collins & Duquid (1989)	Choi, J. & Hannafin, M. (1995). Situated Cognition and Learning Environments: Roles, Structures, and Implications for Design. Educational Technology Research and Development, 43(2), 53-69.	The Role of Content. Cognitive Apprenticeships. Brown, et al. (1989), Collins, Brown, & Holum (1993)
Brown, Collins & Duquid (1989)	Choi, J. & Hannafin, M. (1995). Situated Cognition and Learning Environments: Roles, Structures, and Implications for Design. Educational Technology Research and Development, 43(2), 53-69.	The role of content. Knowledge as Tool Brown, et al. (1989), Cognition and Technology Group at Vanderbilt (1990), Collins (1988)
Brown, Collins & Duquid (1989)	Choi, J. & Hannafin, M. (1995). Situated Cognition and Learning Environments: Roles, Structures, and Implications for Design. Educational Technology Research and Development, 43(2), 53-69.	The Role of Context - Everyday Cognition - Brown, Collins, & Duguid (1989),
Brown, Collins & Duquid (1989)	Choi, J. & Hannafin, M. (1995). Situated Cognition and Learning Environments: Roles, Structures, and Implications for Design. Educational Technology Research and Development, 43(2), 53-69.	Within a culture, ideas are exchanged and modified and belief systems developed and refined through conversation and discourse (Brown, Collins, & Duguid, 1989). Since learning is in part cultivated through social discourse, group interaction is essential. Within groups, social interaction and conversation occur in ways that professionally create and modify the beliefs on individuals.
Brown, Collins & Duquid (1989)	Choi, J. & Hannafin, M. (1995). Situated Cognition and Learning Environments: Roles, Structures, and Implications for Design. Educational Technology Research and Development, 43(2), 53-69.	"Knowledge and tools can only be fully understood through use, and using them entails changing the user's view of the world" (Brown et al., 1989, p. 33).
Brown, Collins & Duquid (1989)	Choi, J. & Hannafin, M. (1995). Situated Cognition and Learning Environments: Roles, Structures, and Implications for Design. Educational Technology Research and Development, 43(2), 53-69.	Knowledge is assumed to be the dynamic by-product of unique relationships between an individual and the environment; learning, then, is a natural by-product of individuals engaged within contexts in which knowledge is embedded naturally (Bednar, Cunningham, Duffy, & Perry, 1991; Brown, Collins, & Duguid, 1989).
Brown, Collins & Duquid (1989)	Choi, J. & Hannafin, M. (1995). Situated Cognition and Learning Environments: Roles, Structures, and Implications for Design. Educational Technology Research and Development, 43(2), 53-69.	When the mentor's thinking is made accessible to the apprentice, and the apprentice's thinking is evident to the mentor, it is increasingly possible to improve both action and underlying processes (Brown, Collins, & Duguid, 1989; Collins, Brown, & Newman, 1989; Collins, 1988).
Brown, Collins & Duquid (1989)	Choi, J. & Hannafin, M. (1997). The Effects of Instructional Context and Reasoning Complexity on Mathematics Problem-Solving. Educational Technology Research and Development, 45(3), 43-55.	The significance of these perspectives is their emphasis on constructive processes among students and the interplay among the teaching, learning, and performing contexts. They suggest that cognition is situated in, rather than isolated from, context. Contexts and associated activities are integral to knowing and understanding (Brown, Collins, & Duguid, 1989; Brown & Palincsar, 1989).
Brown, Collins & Duquid (1989)	Cobb, T. (1999). Applying Constructivism: A Test for the Learner-as-Scientist. Educational Technology Research and Development, 47(3), 15-31.	A constructivist model of learning has been as an alternative to the transmission model implicit in most behaviorist and some cognitive approaches (Brown, Collins, & Duguid, 1989).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Brown, Collins & Duquid (1989)	Cobb, T. (1999). Applying Constructivism: A Test for the Learner-as-Scientist. Educational Technology Research and Development, 47(3), 15-31.	Among the small number of empirical studies cited by Brown et al. (1989) as support for constructivism was a study of vocabulary acquisition conducted by Miller and Gildea (1987).
Brown, Collins & Duquid (1989)	Darabi, A. (2005). Application of Cognitive Apprenticeship Model to a Graduate Course in Performance Systems Analysis: A Case Study. Educational Technology Research and Development, 53(1), 49-61.	Even though not considered a theory in the scientific sense, cognitive apprenticeship (CA; Collins et al., 1991) is a well-recognized instructional approach with extensive roots in the instructional design literature (Brown, Collins, & Duguid, 1989; Ceci, Rosenblum, & De Bruyn, 1998; Quinn, 1994, 1995; Tripp, 1994) that is prescribed for designing learning environments.
Brown, Collins & Duquid (1989)	Dickey, M. (2007). Game Design and Learning: A Conjectural Analysis of How Massively Multiple Online Role-Playing Games (MMORPGs) Foster Intrinsic Motivation. Educational Technology Research and Development, 55(3), 253-273.	As Winn and Snyder (1996) noted, research in situated learning reveals that cognition is more likely to be dependent upon context and affordances of a place and situation than to be determined by formal reasoning (Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991; Suchman, 1987).
Brown, Collins & Duquid (1989)	Dunlap, J. (2005). Problem-Based Learning and Self-Efficacy: How a Capstone Course Prepares Students for a Profession. Educational Technology Research and Development, 53(1), 65-83.	According to Brown, Collins, and Duguid (1989, p. 34), “the activities of a domain are framed by its culture.” However, conventional schooling tends to expose students only to the culture of the classroom, not to the culture in which the content and skills they are learning are naturally applied. Although students are exposed to the tools of a domain’s culture during their academic careers, that exposure can be somewhat antithetical to the real requirements of successful professional activity within that domain.
Brown, Collins & Duquid (1989)	Dunlap, J. (2005). Problem-Based Learning and Self-Efficacy: How a Capstone Course Prepares Students for a Profession. Educational Technology Research and Development, 53(1), 65-83.	Through their participation in a PBL environment that required them to take on the role of software developers and practice solving problems that professionals face in the real world, students learned to use the knowledge, skills, and tools of the domain as professionals use them. Acting as practitioners and using the culture’s knowledge, skills, and tools to address authentic problems exposes students to the culture of expert practice (Brown et al., 1989).
Brown, Collins & Duquid (1989)	Dunn, T. (1994). If We Can't Contextualize It, Should We Teach It? Educational Technology Research and Development, 42(3), 83-92.	It should be noted that some constructivists do address the question of outcomes, thereby providing a focus for evaluation. For example: "The goal is to improve the student's ability to use knowledge in authentic tasks" (Brown, et al., 1989); "To what degree does learners' constructed knowledge of the field permit them to function effectively in the discipline.., and to what extent can they defend their judgments? (Bednar, et al., 1992, p. 29).
Brown, Collins & Duquid (1989)	Dunn, T. (1994). If We Can't Contextualize It, Should We Teach It? Educational Technology Research and Development, 42(3), 83-92.	First of all, constructivists reason that if we do indeed construct our reality and learn nothing that is not somehow context specific, then instruction should take place in rich contexts that reflect the real world and are as closely related as possible to contexts in which this knowledge would subsequently be used, thereby maximizing motivation and transfer (Brown, Collins & Duguid, 1989).

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Brown, Collins & Duquid (1989)	Dunn, T. (1994). If We Can't Contextualize It, Should We Teach It? Educational Technology Research and Development, 42(3), 83-92.	Logically, the "coach" or teacher in these situations is considered to know more about the knowledge domain than the learner, as opposed to just being good in the general sense at collaborating, questioning, and encouraging. Constructivists, of course, hope that coaches respect and encourage students' constructions of knowledge as opposed to encouraging duplication of their cognitive structures, or some hypothetical context-independent structures (Brown, Collins & Duguid, 1989). Even so, these actions are taking place in particular knowledge domains and the coach will need to make decisions during coaching processes regarding the adequacy of the learner's knowledge base. It is at this point that ISD analyses could help substantially. These analyses will help the coach determine where the learner's knowledge is weak, what is lacking, and perhaps what experiences will likely be most helpful. The reader may have in mind some complex learning hierarchy that the teacher uses as a guide. Indeed this could be the case. However, the sequence is not meant to be rigid here, with implied mastery of each step. Instead, the hierarchy or any other form of analysis can serve as a guide. One could ask that without such a guide how are coaches supposed to make their decisions? How will they be able to determine the zone of proximal development? How will they be able to design scaffolding activities? How will they know when the learner will no longer need a particular level of support? How will they be able to determine the nature of cases and/or problems for students to encounter in various contexts? Can these decisions be made independent of some form of analysis of the knowledge domain?
Brown, Collins & Duquid (1989)	Glazer, E., Hannafin, M., & Song, L. (2005). Promoting Technology Integration Through Collaborative Apprenticeship. Educational Technology Research and Development, 53(4), 57-67.	Practicing teachers often learn about integrating technological tools outside of their classroom environment during summer or weekend workshops, and have only limited opportunities to apply and evaluate what they have learned. When learning is not situated in authentic environments, knowledge and skills tend to become more abstract and less meaningful (Brown, Collins, & Duguid, 1989).
Brown, Collins & Duquid (1989)	Glazer, E., Hannafin, M., & Song, L. (2005). Promoting Technology Integration Through Collaborative Apprenticeship. Educational Technology Research and Development, 53(4), 57-67.	Consistent with situated learning perspectives, teachers observe and experience effective practices in their schools because “learning and cognition are fundamentally situated” (Brown et al., 1989).
Brown, Collins & Duquid (1989)	Glazer, E., Hannafin, M., & Song, L. (2005). Promoting Technology Integration Through Collaborative Apprenticeship. Educational Technology Research and Development, 53(4), 57-67.	During collaborative apprenticeships, teachers receive just-in-time assistance; that is, support on demand. In professional and situated environments, learning becomes most meaningful and relevant when it is necessary to complete a task (Brown et al., 1989).
Brown, Collins & Duquid (1989)	Gulikers, J., Bastiaens, T., & Kirschner, P. (2004). A Five-Dimensional Framework for Authentic Assessment. Educational Technology Research and Development, 52(3), 67-86.	The physical context of an authentic assessment should reflect the way knowledge, skills, and attitudes will be used in professional practice (Brown et al., 1989; Herrington & Oliver, 2000).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Brown, Collins & Duquid (1989)	Gulikers, J., Bastiaens, T., & Kirschner, P. (2004). A Five-Dimensional Framework for Authentic Assessment. Educational Technology Research and Development, 52(3), 67-86.	This does not mean that we dismiss the concept of authentic academic achievement (Newmann, 1997), but rather that we see it as a specific subset within a specific field of endeavor, namely becoming an academic. In this we concur with Brown, Collins and Duguid (1989) who, too, saw authentic achievement to be more than authentic academic achievement.
Brown, Collins & Duquid (1989)	Hannafin, M. (1992). Emerging Technologies, ISD, and Learning Environments: Critical Perspectives. Educational Technology Research and Development, 40(1), 49-63.	Developments in situated cognition (Brown, Collins, & Duguid, 1989) and related work in anchored instruction (Cognition and Technology Group at Vanderbilt, 1990) are also significant. Such perspectives view cognition and the circumstances supporting learning as inseparable. Rather than decontextualizing learning by isolating and making explicit "required" elements, it may be fundamentally more productive to embed desired elements within "authentic" activities wherein the knowledge and skills naturally reside.
Brown, Collins & Duquid (1989)	Hannafin, M. (1992). Emerging Technologies, ISD, and Learning Environments: Critical Perspectives. Educational Technology Research and Development, 40(1), 49-63.	In other cases, neither external structuring nor strict outcome-based accountability is emphasized. In some fields, learning emphasizes process over product; relevant domains are situated within contexts in which they derive meaning (Bereiter, 1990; Brown, Collins, & Duguid, 1989).
Brown, Collins & Duquid (1989)	Hannafin, M., Hannafin, K., Land, S., & Oliver, K. (1997). Grounded Practice and the Design of Constructivist Learning Environments. Educational Technology Research and Development, 45(3), 101-117.	Constructivist designers draw upon psychological foundations from theories such as situated learning (Brown, Collins, & Duguid, 1989) and socially-shared cognition (Resnick, Levine, & Teasley, 1991).
Brown, Collins & Duquid (1989)	Hannafin, M., Hannafin, K., Land, S., & Oliver, K. (1997). Grounded Practice and the Design of Constructivist Learning Environments. Educational Technology Research and Development, 45(3), 101-117.	Many emerging learning environments derive their foundations from areas such as constructivism (Jonassen, 1991) and situated cognition (Brown, Collins, & Duguid, 1989).
Brown, Collins & Duquid (1989)	Hannafin, R. (2004). Achievement Differences in Structured Versus Unstructured Instructional Geometry Programs. Educational Technology Research and Development, 52(1), 19-32.	Since the late 1980s, many researchers have advocated using computer technology to create more learner-centered open-ended learning environments (OELEs) where learners are provided with varying amounts of help and support in deciding what they need to learn, how to learn, and what resources they need to learn it (e.g., Brown, Collins, & Duguid, 1989; Cognition and Technology Group at Vanderbilt (CTGV), 1992; Kozma, 1994; Land & Hannafin 1996; Oliver & Hannafin, 2001; Scardamalia, Bereiter, & Lamon, 1994; Scardamalia, Bereiter, McLean, Swallow, & Woodruff, 1989).
Brown, Collins & Duquid (1989)	Heng, Y. & Sullivan, H. (2002). Student Performance and Attitudes Using Personalized Mathematics Instruction. Educational Technology Research and Development, 50(1), 21-34.	Comprehending a problem well enough to determine the correct operations to perform is, of course, an essential skill for solving math word problems. Several authors have argued that students are better able to comprehend and solve word problems when the problems are framed in a real-world context (Bransford, Sherwood, Hasselbring, Kinzer, & Williams, 1992; Brown, Collins, & Duguid, 1989; Choi & Hannafin, 1995).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Brown, Collins & Duquid (1989)	Herrington, J. & Oliver, R. (2000). An Instructional Design Framework for Authentic Learning Environments. Educational Technology Research and Development, 48(3), 23-48.	1. Provide authentic context that reflects the way the knowledge will be used in real life (Brown, Collins, & Dugnid, 1989b; Conins,1988; Gabrys, Weiner, & Lesgold, 1993; Harley, 1993; Moore et al., 1994; Pallncsar, 1989; Resnick, 1987; Winn, 1993; Young, 1993):
Brown, Collins & Duquid (1989)	Herrington, J. & Oliver, R. (2000). An Instructional Design Framework for Authentic Learning Environments. Educational Technology Research and Development, 48(3), 23-48.	2. Provide authentic activities (Brown et al., 1989b; Cognition and Technology Group at Vanderbilt [CTGV], 1990a; Griffin, 1995; Harley, 1993; Resnick, 1987; Tripp, 1993; Winn, 1993; Young, 1993):
Brown, Collins & Duquid (1989)	Herrington, J. & Oliver, R. (2000). An Instructional Design Framework for Authentic Learning Environments. Educational Technology Research and Development, 48(3), 23-48.	5. Support collaborative • tasks that are addressed to a group rather than an individual (Alessi, 1996; Brown et al.~ 1989b; Collins et al., 1989; Hooper, 1992; Resnick, 1987; Young, 1993)
Brown, Collins & Duquid (1989)	Herrington, J. & Oliver, R. (2000). An Instructional Design Framework for Authentic Learning Environments. Educational Technology Research and Development, 48(3), 23-48.	5. Support collaborative • construction of knowledge (Bransford, Sherwood, et al., • 1990; Brown et al., 1989b; Cl~V, • 1990a; Collins et aL, 1989; Resnick, 1987; Young, 1993 -----
Brown, Collins & Duquid (1989)	Herrington, J. & Oliver, R. (2000). An Instructional Design Framework for Authentic Learning Environments. Educational Technology Research and Development, 48(3), 23-48.	access to the social periphery or the observation of real-life episodes as they occur (Brown et al., 1989b; Brown & Duguid, 1993; Lave & Wenger, 1991)
Brown, Collins & Duquid (1989)	Herrington, J. & Oliver, R. (2000). An Instructional Design Framework for Authentic Learning Environments. Educational Technology Research and Development, 48(3), 23-48.	authentic context and task (Brown et al., 1989b; Norman, 1993)
Brown, Collins & Duquid (1989)	Herrington, J. & Oliver, R. (2000). An Instructional Design Framework for Authentic Learning Environments. Educational Technology Research and Development, 48(3), 23-48.	However, it was Brown, Collins, and Duguid (1989b) who developed a focus for the theory of situated cognition or situated learning and produced a proposal for a model of instruction that has implications for classroom practice.
Brown, Collins & Duquid (1989)	Herrington, J. & Oliver, R. (2000). An Instructional Design Framework for Authentic Learning Environments. Educational Technology Research and Development, 48(3), 23-48.	However, the principal theorists of situated learning have consistently argued that their model, when further researched and developed, would be a model for teaching with practical classroom applications (Brown, Collins, & Duguid, 1989a; Brown et al., 1989b; Collins, 1988; Collins, Brown, & Newman, 1989).
Brown, Collins & Duquid (1989)	Herrington, J. & Oliver, R. (2000). An Instructional Design Framework for Authentic Learning Environments. Educational Technology Research and Development, 48(3), 23-48.	In a response to the original Brown et al. article (1989b), Wineburg (1989) argued that the abstract representation of knowledge was at least as effective as the situated learning approach and much more readily implemented in the classroom.

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Brown, Collins & Duquid (1989)	Herrington, J. & Oliver, R. (2000). An Instructional Design Framework for Authentic Learning Environments. Educational Technology Research and Development, 48(3), 23-48.	Promote reflection to enable abstractions to be formed • (Brown et al., 1989b; CTGV, 1990a; Collins, 1988; Collins et al., 1989; Resnick, 1987) ----
Brown, Collins & Duquid (1989)	Herrington, J. & Oliver, R. (2000). An Instructional Design Framework for Authentic Learning Environments. Educational Technology Research and Development, 48(3), 23-48.	Provide multiple roles and • different perspectives on the topics from various points of view (Bransford, Sherwood, et al., 1990; Brown et al., 1989b; CTGV, 1990a; CTGV, 1993; Collins et al., 1989; Lave & Wenger, 1991)
Brown, Collins & Duquid (1989)	Herrington, J. & Oliver, R. (2000). An Instructional Design Framework for Authentic Learning Environments. Educational Technology Research and Development, 48(3), 23-48.	Provide multiple roles and • perspectives (Bransford, Sherwood, et al., 1990; Brown et al., 1989b; CTGV, 1990a; •
Brown, Collins & Duquid (1989)	Herrington, J. & Oliver, R. (2000). An Instructional Design Framework for Authentic Learning Environments. Educational Technology Research and Development, 48(3), 23-48.	• a design to preserve the complexity of the real-life setting with 'rich situational affordances' (Brown et al., 1989b; Collins, 1988; Young & McNeese, 1993)
Brown, Collins & Duquid (1989)	Herrington, J. & Oliver, R. (2000). An Instructional Design Framework for Authentic Learning Environments. Educational Technology Research and Development, 48(3), 23-48.	• a design which makes no attempt to fragment or simplify the environment (Brown eta]., 1989b; Honebein, Duffy, & Fishman, 1993; Spiro et al., 1987; Young & McNeese, 1993).
Brown, Collins & Duquid (1989)	Herrington, J. & Oliver, R. (2000). An Instructional Design Framework for Authentic Learning Environments. Educational Technology Research and Development, 48(3), 23-48.	• a large number of resources to enable sustained examination from a number of different perspectives (Brown et al., 1989b; Collins, 1988; Spiro, VispoeL Schmitz, Samarapungavan, & Boeger, 1987; Young & McNeese, 1993)
Brown, Collins & Duquid (1989)	Herrington, J. & Oliver, R. (2000). An Instructional Design Framework for Authentic Learning Environments. Educational Technology Research and Development, 48(3), 23-48.	• ill-defined activities (Brown et al., 1989b; CTGV, 1990a; Wiun, 1993; Young, 1993)
Brown, Collins & Duquid (1989)	Herrington, J. & Oliver, R. (2000). An Instructional Design Framework for Authentic Learning Environments. Educational Technology Research and Development, 48(3), 23-48.	A situated learning environment should provide: • a physical environment that reflects the way the knowledge will ultimately be used (Brown et aL, 1989b; Collins, 1988)
Brown, Collins & Duquid (1989)	Herrington, J. & Oliver, R. (2000). An Instructional Design Framework for Authentic Learning Environments. Educational Technology Research and Development, 48(3), 23-48.	activities which have real-world relevance (Brown et al., 1989b; Cognition and Technology Group at Vanderbilt [CTGV], 1990a; Jonassen, 1991; Resnick, 1987; Winn, 1993; Young, 1993)

Sample Seminal Publication	Citing ETRD Article	Citation Context
Brown, Collins & Duquid (1989)	Herrington, J. & Oliver, R. (2000). An Instructional Design Framework for Authentic Learning Environments. Educational Technology Research and Development, 48(3), 23-48.	Brown et al. (1989b), in their original article presented a nascent theory of situated learning that has the potential to provide a theoretical basis for a new framework for multimedia design and development. From the start they suggested that their model was the beginning of the process of developing a theoretical perspective for successful learning that cognitive science had, to date, not been able to explain. The challenge put to researchers was to identify the critical aspects of situated learning to enable it to translate into teaching methods that could be applied in the classroom.
Brown, Collins & Duquid (1989)	Herrington, J. & Oliver, R. (2000). An Instructional Design Framework for Authentic Learning Environments. Educational Technology Research and Development, 48(3), 23-48.	opportunity for the sharing of narratives and stories (Brown et al., 1989b; Brown & Duguid, 1993; Lave & Wenger, 1991)
Brown, Collins & Duquid (1989)	Hong, H. & Sullivan, F. (2009). Towards an Idea-Centered, Principle-Based Design Approach to Support Learning as Knowledge Creation. Educational Technology Research and Development, 57(5), 613-627.	The design of such activities and practices are often characterized as student-centered (e.g., self directed learning, Hmelo-Silver 2004), situated (e.g., cognitive apprenticeship, Brown et al. 1989), and culturally relevant (e.g., Lee 2001).
Brown, Collins & Duquid (1989)	Hong, H. & Sullivan, F. (2009). Towards an Idea-Centered, Principle-Based Design Approach to Support Learning as Knowledge Creation. Educational Technology Research and Development, 57(5), 613-627.	Learning as participation suggests learning is a process of participating in various cultural practices and shared learning activities (e.g., Brown et al. 1989; Lave and Wenger 1991).
Brown, Collins & Duquid (1989)	Hong, H. & Sullivan, F. (2009). Towards an Idea-Centered, Principle-Based Design Approach to Support Learning as Knowledge Creation. Educational Technology Research and Development, 57(5), 613-627.	The two types of knowledge most frequently discussed are know-that and know-how (Ryle 1949). In various terms, they are also referred to as learning and use (Brown et al. 1989), replicative and applicative knowledge (Broudy 1977), or declarative and procedural knowledge (Anderson 2000).
Brown, Collins & Duquid (1989)	Howard, B., McGee, S., Shin, N., & Shia, R. (2001). The Triarchic Theory of Intelligence and Computer-Based Inquiry Learning. Educational Technology Research and Development, 49(4), 49-69.	By simulating the physical world of a research village around an observatory, the environment was intended to promote learning through simulating (Gredler, 1996) authentic research in stellar astronomy (Brown, Collins, & Duguid, 1989; Cognition and Technology Group at Vanderbilt, 1993).
Brown, Collins & Duquid (1989)	Hung, D. & Chen, D. (2007). Context–Process Authenticity in Learning: Implications for Identity Enculturation and Boundary Crossing. Educational Technology Research and Development, 55(2), 147-167.	Although there are merits to practice fields, Petraglia (1998) pointed out that these simulations are a priori (preauthentication) designs. They have missed the in situ epistemological underpinning important to constructivism and situated cognition (Bredo, 1994; Brown, Collins, & Duguid, 1989; Clancey, 1997).
Brown, Collins & Duquid (1989)	Jonassen, D. (2011). Ask Systems: Interrogative Access to Multiple Ways of Thinking. Educational Technology Research and Development, 59(1), 159-175.	Experts are often hard to locate and access, but a multimedia hypertext system that resembles a conversation with an expert can model that conversation. In essence, the Ask System provides a cognitive apprenticeship framework (Brown et al. 1989) in which the learner can observe, enact, and practice as an apprentice with an expert, whose perspective is represented in the Ask System.

Sample Seminal Publication	Citing ETRD Article	Citation Context
Brown, Collins & Duquid (1989)	Jonassen, D., Campbell, J., & Davidson, M. (1994). Learning with Media: Restructuring the Debate. Educational Technology Research and Development, 42(2), 31-39.	By decontextualizing learning, knowledge becomes inert, that is, the learner acquires a new concept, but is unable to use it. Knowledge continues to remain under construction with each new situation, experience, and activity (Brown et al., 1989).
Brown, Collins & Duquid (1989)	Jonassen, D., Campbell, J., & Davidson, M. (1994). Learning with Media: Restructuring the Debate. Educational Technology Research and Development, 42(2), 31-39.	Perhaps the major failing of instructional systems technology research has been the lack of concern with the effects of context. We test treatments on unsuspecting and often unwilling subjects who have no interest or need to know about the content embedded within our treatments. That instruction and media exist in and rely upon their surrounding context is usually ignored. According to contemporary theories of learning, such as situated learning (Brown, Collins & Duguid, 1989), everyday cognition (Lave, 1988; Rogoff & Lave, 1984), constructivism Oonassen, 1991; Duffy & Jonassen, 1992), intentional learning (Scardamalia, Bereiter, McLean, Swallow & Woodruff, 1989), and cognitive apprenticeship (Collins et al., 1989), learning is most effectively situated in the context of some meaningful, real-world task.
Brown, Collins & Duquid (1989)	Kim, H. & Hannafin, M. (2008). Grounded Design of Web-Enhanced Case-Based Activity. Educational Technology Research and Development, 56(2), 161-179.	Because social practice through conversations and collaboration are central to learning communities (Brown et al., 1989; Lave & Wenger, 1991), activities for sharing stories may increase reflection and transfer of learning.
Brown, Collins & Duquid (1989)	Kim, H. & Hannafin, M. (2008). Grounded Design of Web-Enhanced Case-Based Activity. Educational Technology Research and Development, 56(2), 161-179.	Case knowledge becomes situated in the social and physical contexts of a community as it is repeatedly applied in new contexts (Brown et al., 1989; Schank, 1999); therefore, participation in social practices helps to build the knowledge valued by and relevant to a given community.
Brown, Collins & Duquid (1989)	Kim, H. & Hannafin, M. (2008). Grounded Design of Web-Enhanced Case-Based Activity. Educational Technology Research and Development, 56(2), 161-179.	Peer collaboration is also important in the doing phase. As individuals generate and share ideas, they practice how to articulate ideas and warrant claims while encountering alternative, sometime competing, perspectives (Brown et al., 1989).
Brown, Collins & Duquid (1989)	Kim, H. & Hannafin, M. (2008). Grounded Design of Web-Enhanced Case-Based Activity. Educational Technology Research and Development, 56(2), 161-179.	Psychological foundations emphasize how we think and learn, guiding both the specification of learning goals and associated pedagogical approaches. Consistent with the perspectives of CBR proponents (i.e., Brown et al., 1989; Kolodner et al., 2004; Lave & Wenger, 1991; Schank et al., 1999; Stevens, Collins, & Goldin, 1982), CBA learning environments are situated and constructivistinspired, knowledge is assumed to evolve through repeated experiences and ongoing support
Brown, Collins & Duquid (1989)	Kim, H. & Hannafin, M. (2008). Grounded Design of Web-Enhanced Case-Based Activity. Educational Technology Research and Development, 56(2), 161-179.	Psychological/Cognitive apprentice situated knowledge ------- -Case libraries as collective memory; cases as knowledge, including situations, concepts, culture, insights, and experiences of individuals (Brown et al., 1989; Kolodner & Guzdial, 2000; Lave & Wenger, 1991; Schank, 1999) -
Brown, Collins & Duquid (1989)	Kim, H. & Hannafin, M. (2008). Grounded Design of Web-Enhanced Case-Based Activity. Educational Technology Research and Development, 56(2), 161-179.	Psychological/Cognitive apprentice situated knowledge ------- Participation in social practice for building knowledge (Brown et al., 1989; Lave & Wenger, 1991; Schank, 1999)

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Brown, Collins & Duquid (1989)	Kim, H. & Hannafin, M. (2008). Grounded Design of Web-Enhanced Case-Based Activity. Educational Technology Research and Development, 56(2), 161-179.	Recently, theorists have characterized ‘‘cases’’ as individual knowledge represented and retrieved in the form of stories (Brown, Collins, & Duguid, 1989; Kolodner, 1993; Lave & Wenger, 1991; Schank, 1999).
Brown, Collins & Duquid (1989)	Kim, H. & Hannafin, M. (2008). Grounded Design of Web-Enhanced Case-Based Activity. Educational Technology Research and Development, 56(2), 161-179.	An individual case is represented as knowledge in the form of stories (Lave & Wenger, 1991), which reflect the cultural values, insights, and experiences of individuals (Brown et al., 1989; Shulman, 1992).
Brown, Collins & Duquid (1989)	Kim, H. & Hannafin, M. (2008). Grounded Design of Web-Enhanced Case-Based Activity. Educational Technology Research and Development, 56(2), 161-179.	These interactions introduce novices to the culture and conventions of a given community of practice as they learn to share, interact with, and critique the ideas and actions of peers (Brown et al., 1989; Lave & Wenger, 1991).
Brown, Collins & Duquid (1989)	Kirschner, P. (2004). Design, Development, and Implementation of Electronic Learning Environments for Collaborative Learning. Educational Technology Research and Development, 52(3), 39-46.	Learning needs to be situated in problem solving in real-life contexts (Brown, Collins, & Duguid, 1989) where the environment is rich in information and where there are no right answers (embedded knowledge).
Brown, Collins & Duquid (1989)	Kopcha, T. & Sullivan, H. (2007). Self-Presentation Bias in Surveys of Teachers’ Educational Technology Practices. Educational Technology Research and Development, 55(6), 627-646.	Learner-centered instruction may also involve constructivist-type approaches such as giving learners some control over their instructional objectives and activities in an effort to enhance their ability to construct their own knowledge (Brown, Collins, & Deguid, 1989; Jonassen, 1991).
Brown, Collins & Duquid (1989)	Kopcha, T. (2010). A Systems-Based Approach to Technology Integration Using Mentoring and Communities of Practice. Educational Technology Research and Development, 58(2), 175-190.	Using a systems-based approach to technology integration creates a teacher-centered process for integrating technology. The mentor provides just-in-time support, modeling, and apprenticeship that is situated in the context of the teachers’ classrooms. This is important because it could translate into more complex and substantial uses of technology for learning. Researchers have suggested that these approaches to learning lead to higher levels of motivation, deeper levels of learning, and skills that are transferable to new and unknown situations (Brown et al. 1989; Duffy and Jonassen 1992; Glazer et al. 2005).
Brown, Collins & Duquid (1989)	Kumar, D., Helgeson, S., & White, A. (1994). Computer Technology-Cognitive Psychology Interface and Science Performance Assessment. Educational Technology Research and Development, 42(4), 6-16.	In another prototype study, Young and Kulikowich (1992) assessed student performance in situated learning and problem solving using an interactive video system. [The term situated learning implies that the knowledge acquired is a part of the culture and context it is derived from (Brown, Collins, & Duguid, 1989).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Brown, Collins & Duquid (1989)	Kumar, D., Helgeson, S., & White, A. (1994). Computer Technology-Cognitive Psychology Interface and Science Performance Assessment. Educational Technology Research and Development, 42(4), 6-16.	Interface Theories: Interface theories are operationally defined as an assortment of theories (assumptions, speculations, ideas, concepts, etc.) which are built upon or developed from the principles of computer technology, and which shed light on the understanding of human cognition in interactive learning or problem-solving situations with computer technology. Some examples of interface theories are as follows: cognitive-information-processing theory to represent human knowledge structure similar to human "neural networks" (Clark, 1992; De Mey, 1992), computer as an external memory to aid in human thinking process (Champagne & Klopfer, 1984), omni-directional environments of the hypermedia to represent linear and non-linear thinking (Jonassen, 1988), artificial intelligence techniques to provide expert assistance in learning (Garito, 1991), situated cognition to provide meaningful contexts for learning and problem solving (Brown, Collins, & Duguid, 1989), and parallel vs. serial information processing by the human brain as quasi-algorithmic processes (Schmid & Gerlach, 1986).
Brown, Collins & Duquid (1989)	Laffey, J., Tupper, T., Musser, D., & Wedman, J. (1998). A Computer-Mediated Support System for Project-Based Learning. Educational Technology Research and Development, 46(1), 73-86.	As a system it borrows heavily from work in electronic performance support (Gery, 1991, Laffey, 1995b) and learner-centered software design (Jackson, Stratford, Krajcik, & Soloway, 1995), as well as from the ideas about authentic working and cognitive apprenticeship illustrated by Brown et al. (1989) and underlain by the work of Vygotsky (1978).
Brown, Collins & Duquid (1989)	Laffey, J., Tupper, T., Musser, D., & Wedman, J. (1998). A Computer-Mediated Support System for Project-Based Learning. Educational Technology Research and Development, 46(1), 73-86.	Learning is fundamentally situated, and the production of useable and robust knowledge is supported by tasks and environments that are authentic (Brown, Collins, & Duguid, 1989).
Brown, Collins & Duquid (1989)	Laffey, J., Tupper, T., Musser, D., & Wedman, J. (1998). A Computer-Mediated Support System for Project-Based Learning. Educational Technology Research and Development, 46(1), 73-86.	Immersion in that culture is essential if learners are to build and use the conceptual tools of science as scientists use them (Brown et al., 1989).
Brown, Collins & Duquid (1989)	Land, S. & Hannafin, M. (1996). A Conceptual Framework for the Development of Theories-in-Action with Open-Ended Learning Environments. Educational Technology Research and Development, 44(3), 37-53.	Recent technological developments have enabled researchers to explore the use of computers and related technologies to support a variety of innovative teaching and learning approaches. Contemporary theoretical perspectives such as constructivism (Jonassen, 1991), situated cognition (Brown, Collins, & Duguid, 1989), and cognitive flexibility (Spiro, Feltovich, Jacobson, & Coulson, 1991) emphasize the centrality of the learner to understanding.
Brown, Collins & Duquid (1989)	Land, S. & Hannafin, M. (1996). A Conceptual Framework for the Development of Theories-in-Action with Open-Ended Learning Environments. Educational Technology Research and Development, 44(3), 37-53.	Thinking processes and the contexts in which they occur are inextricably situated, that is, they cannot be separated from their experiential referents (Brown et al., 1989; Perkins & Salomon, 1989).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Brown, Collins & Duquid (1989)	Land, S. & Hannafin, M. (1996). A Conceptual Framework for the Development of Theories-in-Action with Open-Ended Learning Environments. Educational Technology Research and Development, 44(3), 37-53.	Yet, while links to prior knowledge enhance the potential for transfer (Brown et al., 1989), they often reference incomplete and inaccurate understanding which underlie faulty theories.
Brown, Collins & Duquid (1989)	Land, S. &Hannafin, M. (1997). Patterns of Understanding with Open-ended Learning Environments: A Qualitative Study. Educational Technology Research and Development, 45(2), 47-73.	Accompanying perspectives have guided the use of technology through powerful theoretical frameworks of student-centered learning processes (see for example, Brown, Collins, & Duguid, 1989; Spiro et al., 1991).
Brown, Collins & Duquid (1989)	Land, S. (2000). Cognitive Requirements for Learning with Open-Ended Learning Environments. Educational Technology Research and Development, 48(3), 61-78.	Recent trends in learning emphasize the situated nature of knowledge and the impact that contexts, tools, and social interaction have on understanding (Brown, Collins, & Duguid, 1989; Cobb & Bowers, 1999).
Brown, Collins & Duquid (1989)	Larson, M. & Lockee, B. (2009). Preparing Instructional Designers for Different Career Environments: A Case Study. Educational Technology Research and Development, 57(1), 1-24.	Cognitive apprenticeship • Brown, Collins, & Duguid, 1989
Brown, Collins & Duquid (1989)	Larson, M. & Lockee, B. (2009). Preparing Instructional Designers for Different Career Environments: A Case Study. Educational Technology Research and Development, 57(1), 1-24.	The value of mentoring relationships was emphasized by faculty who indicated that they tried to model what they, themselves, had experienced at LU or at previous institutions. Doctoral students fulfill a required research apprenticeship, in which they are assigned to shadow and assist a faculty member in their research efforts. These apprenticeships provide faculty with the opportunity to share their thinking processes using a cognitive apprenticeship model (Brown, Collins, & Duguid, 1989; Ertmer & Stepich, 2003): ‘‘I consider them apprentices… and I hold their hands and get them through the whole process… scaffolding is a part of the whole process… by the end… they are just fine on their own… and… [don't need] my help.’’
Brown, Collins & Duquid (1989)	Lebow, D. (1993). Constructivist Values for Instructional Systems Design: Five Principles Toward a New Mindset. Educational Technology Research and Development, 41(3), 4-16.	Such approaches as cognitive apprenticeship (Collins et al., 1989), project-based learning (Blumenfeld et al., 1991), and experiential learning (Clinchy, 1989) recognize authenticity as an element of transfer. What these approaches share is the idea that meaning is indexed by experience and that "understanding is developed through continued and situated use" (Brown et al., 1989, p. 33), and, thus, the learning situation should promote application and manipulation of knowledge within the context of the ordinary practices of the target culture.
Brown, Collins & Duquid (1989)	Lebow, D. (1993). Constructivist Values for Instructional Systems Design: Five Principles Toward a New Mindset. Educational Technology Research and Development, 41(3), 4-16.	Such holistic beliefs are further reflected in constructivist notions of authentic activity and situated cognition (Brown, Collins, & Duguid, 1989) and in constructivist theories of learning and teaching such as cognitive apprenticeship (Collins, Brown, & Newman, 1989) and cognitive flexibility theory (Spiro, Feltovich, Jacobson, & Coulson, 1991).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Brown, Collins & Duquid (1989)	Lin, X., Hmelo, C., Kinzer, C., & Secules, T. (1999). Designing Technology to Support Reflection. Educational Technology Research and Development, 47(3), 43-62.	There have been two major waves of the "cognitive revolution." DeCorte, Greer and Verschaffel 0996) note that the first wave consisted primarily of analyses of individual thinkers and learners, with a de-emphasis on affect, context, culture and history. With the second wave there have been attempts to relocate cognitive functioning within its social, cultural, and historical contexts (e.g., Brown, Collins, & Duguid, 1989). In this latter view, individual and socially-mediated reflection ai'e complementary and both are important for helping students learn to reflect.
Brown, Collins & Duquid (1989)	Lin, X., Hmelo, C., Kinzer, C., & Secules, T. (1999). Designing Technology to Support Reflection. Educational Technology Research and Development, 47(3), 43-62.	The educational goal for social constructivists is to create social environments that encourage students to construct their own understanding (Brown et al., 1989).
Brown, Collins & Duquid (1989)	Lubin, I. & Xun, G. (2012). Investigating the Influences of a LEAPS Model on Preservice Teachers' Problem Solving, Metacognition, and Motivation in an Educational Technology Course. Educational Technology Research and Development, 60(2), 239-270.	Situated learning focuses on the roles of the physical and social environment and the contextual nature of learning (Lave and Wenger 1991; Brown et al. 1989).
Brown, Collins & Duquid (1989)	Lubin, I. & Xun, G. (2012). Investigating the Influences of a LEAPS Model on Preservice Teachers' Problem Solving, Metacognition, and Motivation in an Educational Technology Course. Educational Technology Research and Development, 60(2), 239-270.	The LEAPS model theoretically samples from situated learning (Brown et al. 1989), human motivation (Maehr 1984), and open learning environments literature (Hannafin et al. 1999).
Brown, Collins & Duquid (1989)	Magliaro, S. & Shambaugh, N. (2006). Student Models of Instructional Design. Educational Technology Research and Development, 54(1), 83-106.	Conceptual change most likely occurs when the individual receives assistance and support in understanding the disconnect between long-held models and evolving representations (Brown, Collins, & Duguid, 1989; Vygotsky, 1978).
Brown, Collins & Duquid (1989)	McCrary, N. & Mazur, J. (2010). Conceptualizing a Narrative Simulation to Promote Dialogic Reflection: Using a Multiple Outcome Design to Engage Teacher Mentors. Educational Technology Research and Development, 58(3), 325-342.	We used narrative because of its potential to be engaging and situate information in familiar contexts (Brown et al. 1989; Cognition and Technology Group at Vanderbilt 1990, 1993; Lave and Wenger 1991; Polkinghorne 1988; Young 1993).
Brown, Collins & Duquid (1989)	Moailem, M. (1998). An Expert Teacher's Thinking and Teaching and Instructional Design Models and Principles: An Ethnographic Study. Educational Technology Research and Development, 46(2), 37-64.	It is a socially situated knowledge (Brown, Collins & Duguid, 1989; Greeno, 1973; Lave, 1988; Resnick, 1990; Suchman, 1987), which is different from that of formal, scientific, research-based knowledge (knowledge that is gained from studies of teaching that use conventional, scientific methods-- quantitative and qualitative) used in the analysis phase of instructional design models.
Brown, Collins & Duquid (1989)	Moallem, M. (2003). An Interactive Online Course: A Collaborative Design Model. Educational Technology Research and Development, 51(4), 85-103.	Moreover, knowledge is often distributed among participants and situated in a specific activity context (Brown, Collins, & Duguid, 1989; Greeno, 1997; Lave & Wenger, 1991).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Brown, Collins & Duquid (1989)	Nadolski, R., Kirscher, P., Van Merriënboer, J., & Hummel, H. (2001). A Model for Optimizing Step Size of Learning Tasks in Competency-based Multimedia Practicals. Educational Technology Research and Development, 49(3), 87-101.	Competency-based Multimedia Practicals (CMPs) provide realistic situations in which meaningful learning through contextualized practice takes place (Brown, Collins, & Duguid, 1989; Westera & Sloep, 1998).
Brown, Collins & Duquid (1989)	Nadolski, R., Kirscher, P., Van Merriënboer, J., & Hummel, H. (2001). A Model for Optimizing Step Size of Learning Tasks in Competency-based Multimedia Practicals. Educational Technology Research and Development, 49(3), 87-101.	Sequencing of learning tasks (Step 4) is pivotal in facilitating the learning process (e.g. Brown et al., 1989; Gagné et al., 1993; Merrill, 1987; Reigeluth, 1983).
Brown, Collins & Duquid (1989)	Nadolski, R., Kirscher, P., Van Merriënboer, J., & Hummel, H. (2001). A Model for Optimizing Step Size of Learning Tasks in Competency-based Multimedia Practicals. Educational Technology Research and Development, 49(3), 87-101.	Situational learning (Brown et al., 1989) emphasizes that such environments need to offer realistic situations where learning through meaningful practice takes place; complex skills-learning occurs most effectively in a relevant context.
Brown, Collins & Duquid (1989)	Nadolski, R., Kirscher, P., Van Merriënboer, J., & Hummel, H. (2001). A Model for Optimizing Step Size of Learning Tasks in Competency-based Multimedia Practicals. Educational Technology Research and Development, 49(3), 87-101.	This knowledge construction is context-dependent and cannot be isolated from situations in which it is learned (Anderson, 1982, 1993; Brown et al., 1989; Kirschner, van Vilsteren, Hummel, & Wigman, 1997; Kolb, 1984; Parreren, 1987).
Brown, Collins & Duquid (1989)	Nelson, B. & Erlandson, B. (2008). Managing Cognitive Load in Educational Multi-User Virtual Environments: Reflection on Design Practice. Educational Technology Research and Development, 56(5), 619-641.	Situated learning proponents define learning as being embedded within and inseparable from participating in a system of activity, deeply determined by a particular physical and cultural setting (Brown et al. 1989; Lave and Wenger 1991).
Brown, Collins & Duquid (1989)	Oliver, K. & Hannafin, M. (2001). Developing and Refining Mental Models in Open-Ended Learning Environments: A Case Study. Educational Technology Research and Development, 49(4), 5-32.	When provided open-ended situations and appropriate scaffolding, however, students can gradually reconcile their naive models with those of experts. Hybrid mental models emerge that reflect formative detail and assumptions, models used to formalize and test beliefs. Student-apprentices in such environments, with the tutelage of teachers and other mentors, help to refine and fine-tune these formative models as their understanding deepens (Baxter, 1995; Brown, Collins, & Duguid, 1989; Vosniadou, 1994).
Brown, Collins & Duquid (1989)	Oliver, R. & Reeves, T. (1996). Dimensions of Effective Interactive Learning with Telematics for Distance Education. Educational Technology Research and Development, 44(4), 45-56.	A major criticism of current dominant pedagogical schemes is that they are too abstract, removed as they are from real world experience (cf., Brown, Collins, & Duguid, 1989).
Brown, Collins & Duquid (1989)	Oshima, J., Oshima, R., & Yoshiaki, M. (2012). Knowledge Building Discourse Explorer: A Social Network Analysis Application for Knowledge Building Discourse. Educational Technology Research and Development, 60(5), 903-921.	. In this way, knowledge is not present in individual human minds, but is an aspect of participation in cultural practices (Brown et al. 1989; Lave and Wenger 1991).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Brown, Collins & Duquid (1989)	Oshima, J., Oshima, R., & Yoshiaki, M. (2012). Knowledge Building Discourse Explorer: A Social Network Analysis Application for Knowledge Building Discourse. Educational Technology Research and Development, 60(5), 903-921.	Hence, learning takes place through participation in practices and actions (Anderson et al. 1996; Greeno 1997), enculturation (Brown et al. 1989), or legitimate peripheral participation (Lave and Wenger 1991).
Brown, Collins & Duquid (1989)	Park, I. & Hannafin, M. (1993). Empirically-Based Guidelines for the Design of Interactive Multimedia. Educational Technology Research and Development, 41(3), 63-85.	Learners acquire not only literal knowledge of lesson content, but important understandings of the contexts in which knowledge is acquired. Many (e.g., Brown et al., 1989) view learning and cognition as being situated, that is, knowledge and context are inextricably tied. For example, students are often presented isolated definitions apart from the contexts of their "natural" use. Consequently, the terms lack natural meaning, which makes them difficult for students to understand. In contrast, learning in contexts that are "ecologically valid" is often more rapid, durable, and transferable.
Brown, Collins & Duquid (1989)	Park, I. & Hannafin, M. (1993). Empirically-Based Guidelines for the Design of Interactive Multimedia. Educational Technology Research and Development, 41(3), 63-85.	Situated Learning Brown, Collins, & Duguid (1989)
Brown, Collins & Duquid (1989)	Park, I. & Hannafin, M. (1993). Empirically-Based Guidelines for the Design of Interactive Multimedia. Educational Technology Research and Development, 41(3), 63-85.	General psychological principles are largely media-independent. Psychological constructs such as schemata (Anderson, Spiro, & Anderson, 1978; Norman, Gentner, & Stevens, 1976); meaningful learning (Mayer, 1984); elaboration (Rohwer, 1980); and situated cognition (Brown, Collins, & Duguid, 1989) emphasize how individuals organize and retrieve knowledge and establish meaning, and hence have far-reaching implications for the design of learning systems.
Brown, Collins & Duquid (1989)	Quinn, J. (1994). Connecting Education and Practice in an Instructional Design Graduate Program. Educational Technology Research and Development, 42(3), 71-82.	Such an epistemology of professional practice is also supported by current research in cognition and the development of expertise. Research on the acquisition of procedural knowledge suggests that such knowledge is learned and transformed into useful forms principally through practice (GagnG 1985; Lesgold et al., 1988, Brown, Collins, & Duguid, 1989; Cognition and Technology Group at Vanderbilt, 1990).
Brown, Collins & Duquid (1989)	Rieber, L. (1992). Computer-Based Microworlds: A Bridge Between Constructivism and Direct Instruction. Educational Technology Research and Development, 40(1), 93-106.	Instructional applications of microworlds conform to the idea of the zone of proximal development (Vygotsky, 1978, 1986), wherein individuals who are on the threshold of learning are often unable" to reach understanding without some kind of externally provided assistance or intervention. Similar issues have been discussed by advocates of generative learning (Jonassen, 1988; Wittrock, 1974, 1978) and, more recently, those of situated cognition, who hold that learning should be based (situated) in the context in which it is to be applied (Brown, Collins, & Duguid, 1989).
Brown, Collins & Duquid (1989)	Rieber, L. (1995). A Historical Review of Visualization in Human Cognition. Educational Technology Research and Development, 43(1), 45-56.	Lave's work is often cited by proponents of situated cognition (e.g. Brown, Collins, & Duguid, 1989), though these examples also show how everyday people use spatial and concrete reasoning abilities to grapple with problems often expressed in abstract form in traditional mathematics.

Sample Seminal Publication	Citing ETRD Article	Citation Context
Brown, Collins & Duquid (1989)	Rieber, L. (1996). Seriously Considering Play: Designing Interactive Learning Environments Based on the Blending of Microworlds, Simulations, and Games. Educational Technology Research and Development, 44(2), 43-58.	Given the natural role that play and imitation serve to intellectual development, game playing and game designing can also be considered as authentic tasks for children. Researchers have stressed the importance of anchoring, or situating, learning in authentic situations (Brown, Collins & Duguid, 1989; Choi & Hannafin, 1995; Cognition and Technology Group at Vanderbilt, 1990).
Brown, Collins & Duquid (1989)	Saye, J. & Brush, T. (2002). Scaffolding Critical Reasoning About History and Social Issues in Multimedia-Supported Learning Environments. Educational Technology Research and Development, 50(3), 77-96.	Situated cognition theorists have advocated a process of cognitive apprenticeship that involves modeling problem solving, supporting students' developing understandings through scaffolding and coaching, and gradually decreasing guidance as student thinking becomes more expert (Brown, Collins, & Duguid, 1989).
Brown, Collins & Duquid (1989)	Seels, B., Campbell, S., & Talsma, V. (2003). Supporting Excellence in Technology Through Communities of Learners. Educational Technology Research and Development, 51(1), 91-104.	Teachers, like their students, construct their knowledge by integrating new learning with prior knowledge and beliefs, applying ideas to practice, and evaluating and reflecting on the results (Brown, Collins, & Duguid, 1989; Fenstermacher & Richardson, 1993; Hargreaves & Fullan, 1992; Jenlink & Kinnucan-Welsch, 2001; McCotter, 2001; Prawat, 1992; Sarason, 1993; Soloway et al., 1996).
Brown, Collins & Duquid (1989)	Seels, B., Campbell, S., & Talsma, V. (2003). Supporting Excellence in Technology Through Communities of Learners. Educational Technology Research and Development, 51(1), 91-104.	Learning advances through collaborative social interaction and the social construction of knowledge (Brown et al., 1989).
Brown, Collins & Duquid (1989)	Shambaugh, N. & Magliaro, S. (2001). A Reflexive Model for Teaching Instructional Design. Educational Technology Research and Development, 49(2), 69-92.	Our second tenet holds the notion that learning is situated and mediated in social contexts (Brown et al., 1989; Lave & Wenger, 1991).
Brown, Collins & Duquid (1989)	Shambaugh, N. & Magliaro, S. (2001). A Reflexive Model for Teaching Instructional Design. Educational Technology Research and Development, 49(2), 69-92.	Three complimentary tenets from contemporary learning theory serve as the foundation of our instructional approach: (a) that learning is a constructive process (e.g., Bruner, 1990); (b) that learning is situated and mediated in social contexts (Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991); and (c) that teaching is "assisted performance" (Tharp & Gallimore, 1988).
Brown, Collins & Duquid (1989)	Shambaugh, N. & Magliaro, S. (2001). A Reflexive Model for Teaching Instructional Design. Educational Technology Research and Development, 49(2), 69-92.	While prior knowledge and experience enable novice instructional designers to enter the ID arena, it is through the assistance of more capable others (i.e., instructors and developers) that they can actively build on what they already know about instructional design and the instructional problem (Brown et al., 1989).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Brown, Collins & Duquid (1989)	Squire, K. & Johnson, C. (2000). Supporting Distributed Communities of Practice with Interactive Television. Educational Technology Research and Development, 48(1), 23-43.	Facilitators in each case needed to remind experts of their role in the learning environment. In the Racetrack case, facilitators had difficulty stopping racetrack experts from lecturing; the experts were approaching the environment with a "transmission" vision of learning, and tending to lecture students on material that was not relevant to classroom activity. In the Creating case, the instructor primed experts on their role in the classroom, ensuring a more consistent pedagogical approach. Still, she found it useful to prompt experts to explain their thinking more fully. For example, the instructor found that facilitatorexpert review of student work prompted experts to "think-aloud," thus ensuring that students could gain insight into expert thinking, an integral component of the cognitive apprenticeship (Brown, et al., 1989). In the Northern Ireland case, however, instructors did not structure reflection exercises into the instruction, and thus missed opportunities to push students' understanding further.
Brown, Collins & Duquid (1989)	Squire, K. & Johnson, C. (2000). Supporting Distributed Communities of Practice with Interactive Television. Educational Technology Research and Development, 48(1), 23-43.	This change in the conceptualization of learning might be characterized as one that goes from learning as a process of acquiring an abstract set of symbols, to one where learning is doing (Brown, Collins, & Duguid, 1989).
Brown, Collins & Duquid (1989)	Sullivan, F., Hamilton, C., Allessio, D., Boit, R., Deschamps, A., Sindelar, T., Ramos, G., Randall, A., Wilson, N., & Yan, Z. (2011). Representational Guidance and Student Engagement: Examining Designs for Collaboration in Online Synchronous Environments. Educational Technology Research and Development, 59(5), 619-644.	The design of many educational MUVEs is built on the theory of situated learning (Brown et al. 1989); such design centers on enabling participatory and interactive learning experiences for students (Barab and Dede 2007).
Brown, Collins & Duquid (1989)	Tennyson, R., Elmore, R., & Snyder, L. (1992). Advancements in Instructional Design Theory: Contextual Module Analysis and Integrated Instructional Strategies. Educational Technology Research and Development, 40(2), 9-22.	Thus, the key to both effective acquisition and employment of knowledge is the organization of the information according to contextual applications. That is, contextual knowledge indudes not only information (i.e., content/task), but also the cultural aspects directly associated with that information (Brown, Collins, & Duguid, 1989). Cultural aspects are the selection criteria, values, feelings, and appropriateness associated with the information of given contextual situations.
Brown, Collins & Duquid (1989)	Teslow, J. (1995). Humor Me: A Call for Research. Educational Technology Research and Development, 43(3), 6-28.	Merrill (1980) reminds us that the ultimate learning environment is life itself. The situated cognition movement stresses the importance of learning knowledge and skills in authentic contexts that reflect the real world (Brown, Collins, & Duguid, 1989).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Brown, Collins & Duquid (1989)	Tessmer, M., Wilson, B., & Driscoll, M. (1990). A New Model of Concept Teaching and Learning. Educational Technology Research and Development, 38(1),45-53.	Over time, a concept may become a schema or network itself, instead of a node or component of one. In many cases, concepts such as "'giftedness," "cost-benefit analysis," or "glasnost" may have an enormous amount of declarative and procedural knowledge attached to them, what Carroll (1964) has called the "cognitive and affective components of concepts." Such concepts are not so much learned through definitions as acquired over time (Brown et al., 1989) through use and experience
Brown, Collins & Duquid (1989)	Tessmer, M., Wilson, B., & Driscoll, M. (1990). A New Model of Concept Teaching and Learning. Educational Technology Research and Development, 38(1),45-53.	Two concept performance measures that reflect "higher" kinds of cognitive activity are: using a concept (e.g., writing stories or sentences, role playing) and generating inferences about a concept (e.g., theorizing, drawing implications, understanding context). These uses and inferences reflect a conceptualtools view of concept learning, where the inferences drawn from concepts (J. Wilson, 1971; Shavelson, 1974; Smith & Medin, 1981) and the uses of the concept (Markle, 1975; Brown et al., 1989) are part of the purposes and determinants of concept learning.
Brown, Collins & Duquid (1989)	Tessmer, M., Wilson, B., & Driscoll, M. (1990). A New Model of Concept Teaching and Learning. Educational Technology Research and Development, 38(1),45-53.	Using the concept in conversation, writing, and argumentation: to communicate intelligently about the concept (Brown et al., 1989);
Brown, Collins & Duquid (1989)	Tessmer, M., Wilson, B., & Driscoll, M. (1990). A New Model of Concept Teaching and Learning. Educational Technology Research and Development, 38(1),45-53.	As Brown, Collins & Duguid (1989) indicate, conceptual knowledge is more like a set of tools used for different contextual purposes than a collection of abstract definitions.
Brown, Collins & Duquid (1989)	Thurman, R. (1993). Instructional Simulation from a Cognitive Psychology Viewpoint. Educational Technology Research and Development, 41(4), 75-89.	Modern theories of learning, cognition, and instruction imply that students engage in meaningful interactive learning environments from which they construct mental models (Brown, Collins, & Duguid, 1989). However, learning from actual situations can be expensive, is often not sufficient, and is usually not practical for many learning tasks. Therefore, efficient learning may require the availability and use of simulations and microworlds (or, for that matter, other interactive learning environments). Thanks to the microcomputer, such environments are now possible and quite affordable
Brown, Collins & Duquid (1989)	Van Eck, R. & Dempsey, J. (2002). The Effect of Competition and Contextualized Advisement on the Transfer of Mathematics Skills in a Computer-Based Instructional Simulation Game. Educational Technology Research and Development, 50(3), 23-41.	Brown (1989) found that simply prompting learners to consider prior learning improved transfer, and Brown's finding has been replicated by other researchers as well (e.g., Gick & Holyoak, 1980; Hayes & Simon, 1977; Perfetto et al., 1983; Reed et al., 1974; Simon & Hayes, 1976; Weisberg et al., 1978).
Brown, Collins & Duquid (1989)	Van Eck, R. & Dempsey, J. (2002). The Effect of Competition and Contextualized Advisement on the Transfer of Mathematics Skills in a Computer-Based Instructional Simulation Game. Educational Technology Research and Development, 50(3), 23-41.	This may be because problem solving and transfer are largely domain and context specific (e.g., Bransford, Franks, Vye, & Sherwood, 1989; Bransford, Sherwood, Vye, & Rieser, 1986; Brown, Collins, & Duguid, 1989; Perkins & Salomon, 1989), and thus require multiple practice opportunities in a variety of contexts (Gagné, Briggs, & Wager, 1992). Such opportunities may be limited in formal education.

Sample Seminal Publication	Citing ETRD Article	Citation Context
Brown, Collins & Duquid (1989)	West, R. (2009). What is Shared? A Framework for Understanding Shared Innovation within Communities. Educational Technology Research and Development, 57(3), 315-332.	Brown et al. (1989) based many of their ideas on the work of Lave, who with Wenger developed theories about learning and working within COP (Lave and Wenger 1991).
Brown, Collins & Duquid (1989)	West, R. (2009). What is Shared? A Framework for Understanding Shared Innovation within Communities. Educational Technology Research and Development, 57(3), 315-332.	Brown et al. (1989) presented a ‘‘fragment’’ of the theory of situated cognition by explaining that knowledge is inescapably tied to the context and practice in which it was used.
Brown, Collins & Duquid (1989)	West, R. (2009). What is Shared? A Framework for Understanding Shared Innovation within Communities. Educational Technology Research and Development, 57(3), 315-332.	Building from this conception of knowledge, Brown et al. (1989) argued that learning requires a student ‘‘like an apprentice, [to] enter that community and its culture’’ (p. 33).
Brown, Collins & Duquid (1989)	Wilson, B. & Cole, P. (1991). A Review of Cognitive Teaching Models. Educational Technology Research and Development, 39(4), 47-64.	2. Situated learning: Teach knowledge and skills in contexts that reflect the way the knowledge will be useful in real life. Brown, Collins, and Duguid (1989) argue for placing all instruction within "authentic" contexts that mirror real-life problem-solving situations.
Brown, Collins & Duquid (1989)	Wilson, B. & Cole, P. (1991). A Review of Cognitive Teaching Models. Educational Technology Research and Development, 39(4), 47-64.	Brown, Collins, and Duguid (1989) define authentic activity as "the ordinary practices of the culture" (p. 34). We take this to mean that they have some bearing on real-life, everyday activities. There is a problem, however, in determining what counts as authentic activity. Apparently, the theorizing and inquiry activities of a nuclear physicist or historian qualify as authentic. For the term to have any precise referent, there needs to be a boundary drawn between authentic and unauthentic activity, and we are not sure where that boundary lies. Upon examining the set of teaching models, however, there seems to be a continuum of authenticity. Some programs relate more closely to real-life situations (e.g., the Jasper series), but most are more typically academic work (e.g., Anderson's LISP tutor). Some programs seem to fall in the middle (Spiro's KANE or Harel and Papert's fractions project). Clearly, the resemblance between the instructional setting and real-life settings is not a constant among the models.
Brown, Collins & Duquid (1989)	Wilson, B. & Cole, P. (1991). A Review of Cognitive Teaching Models. Educational Technology Research and Development, 39(4), 47-64.	The cognitive apprenticeship model rests on a somewhat romantic conception of the "ideal" apprenticeship as a method of becoming a master in a complex domain (Brown, Collins, & Duguid, 1989).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Brown, Collins & Duquid (1989)	Wilson, B. & Cole, P. (1992). A Critical Review of Elaboration Theory. Educational Technology Research and Development, 40(3), 63-79.	A number of psychologists have added the situation or context of use as part of what gets learned (Brown, Collins, & Duguid, 1989). Rather than thinking of expertise as the acquisition of a general schema, they claim that learning and expertise are always embedded in a particular physical, social, and cultural context. Learning is a matter of enculturation, that is, of becoming part of a community which jointly constructs meaning. Seen in this way, the context of use becomes part of the "content structure" in need of analysis and representation for the design of instruction.
Brown, Collins & Duquid (1989)	Woolf, N. & Quinn, J. (2009). Learners' Perceptions of Instructional Design Practice in a Situated Learning Activity. Educational Technology Research and Development, 57(1), 25-43.	Over the last 25 years, a substantive body of knowledge has emerged expressing the need for professional education programs to not only develop in learners the technical knowledge and skills required for professional practice, but also the practical knowledge necessary for success in dealing with the often uncertain, illstructured, and complex nature of professional practice. The theoretical foundations for such approaches are drawn from a variety of models for structuring learning from experience (Dewey, 1963), including the reflective practicum (Scho¨ n, 1990), situated learning and situated cognition (Brown, Collins, & Duguid, 1989), legitimate peripheral participation within communities of practice (Lave & Wenger, 1991), cognitive apprenticeship (Collins, Brown, & Holum, 1991), and problem-based learning (Barrows, 1994; Regnier, Welsh, & Quarton, 1994; Savery & Duffy, 2001).
Brown, Collins & Duquid (1989)	Xiaoli, Z. & Bishop, M. (2011). Understanding and Supporting Online Communities of Practice: Lessons Learned from Wikipedia. Educational Technology Research and Development, 59(5), 711-735.	Situated learning theorists posit that learning is situated—that it is the product of the activity, context, and culture in which it occurs (Brown et al. 1989; Greeno 1998; Lave and Wenger 1991).
Brown, Collins & Duquid (1989)	Barab, S., Squire, K., & Dueber, W. (2000). A Co-Evolutionary Model for Supporting the Emergence of Authenticity. Educational Technology Research and Development, 48(2), 37-62.	Second are those theories that arose in educational circles, which are partly inspired by the work of the anthropologists but also in reaction to an increasing dissatisfaction with the practices of schools (Brown & Campione, 1990; Brown et al., 1989; Cognition and Technology Group at Vanderbilt [CTGV], 1990, 1993; Collins, Brown, & Newman, 1989; Resnick, 1987).
Brown, Collins & Duquid (1989)	Barab, S., Squire, K., & Dueber, W. (2000). A Co-Evolutionary Model for Supporting the Emergence of Authenticity. Educational Technology Research and Development, 48(2), 37-62.	The American educational system, as considered separate from hands-on apprenticeships, has in some sense maintained its identity by accentuating the distinction between those engaged in applied practices and those engaged in abstract intellectualizing (Brown et al., 1989).
Brown, Collins & Duquid (1989)	Barab, S., Squire, K., & Dueber, W. (2000). A Co-Evolutionary Model for Supporting the Emergence of Authenticity. Educational Technology Research and Development, 48(2), 37-62.	This is because the separation of learning from authentic use creates a content-culture incongruity in which students are learning content implicitly framed in the culture of schools, but whose use and value is explicitly attributed to authentic communities of practice that are not directly in evidence (Barab & Duffy, 2000; Brown et al., 1989).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Brown, Collins & Duquid (1989)	Barab, S., Squire, K., & Dueber, W. (2000). A Co-Evolutionary Model for Supporting the Emergence of Authenticity. Educational Technology Research and Development, 48(2), 37-62.	Whether the teaching of technology occurs through didactic lectures or through cleverly designed open-ended projects, if the learning occurs exclusively in the university context there will continue to be a gap between school learning and real-world application (Barab & Landa, 1997; Brown, Collins, & Duguid, 1989).
Brown, Collins & Duquid (1989)	Clinton, G. & Rieber, L. (2010). The Studio Experience at the University of Georgia: An Example of Constructionist Learning for Adults. Educational Technology Research and Development, 58(6), 755-780.	After constructivism, the next most important theoretical construct influencing the Studio curriculum has been situated cognition. A seminal article advocating for situated cognition was Brown et al. (1989). Major concepts in this article included situated cognition, cognitive apprenticeship, scaffolding, communities of practice, legitimate peripheral participation (situated learning), and enculturation. Brown, Collins, and Duguid heavily cited the work of Jean Lave (see the discussion of situated learning below).
Brown, Collins & Duquid (1989)	Clinton, G. & Rieber, L. (2010). The Studio Experience at the University of Georgia: An Example of Constructionist Learning for Adults. Educational Technology Research and Development, 58(6), 755-780.	For example, Brown et al. (1989 discussed successful models of cognitive apprenticeship in which classroom instruction was presented by teachers modeling the reasoning processes of mathematics professionals rather than those of typical math teachers.
Brown, Collins & Duquid (1989)	Dávila, J. & Keirns, J. (1994). The Effect of Co-Designing on Educational Transfer Between Cultures. Educational Technology Research and Development, 42(4), 89-100.	Furthermore, the know how, devoid of its cultural context, leads to weaker learning (Brown, Collins and Duguid, 1989) because it defeats the goal of training, that is, for learners to learn to use the instrument and to understand the conditions under which the instrument is appropriate and effective.
Brown, Collins & Duquid (1989)	Dickey, M. (2011). The Pragmatics of Virtual Worlds for K-12 Educators: Investigating the Affordances and Constraints of Active Worlds and Second Life with K-12 in-Service Teachers. Educational Technology Research and Development, 59(1), 1-20.	From the works of Dewey to the present day, researchers as diverse as Kolb (1984), Eisner (1997), and Brown et al. (1989) have valued the importance of reflection to the learning process.
Brown, Collins & Duquid (1989)	Fishman, B. & Duffy, T. (1992). Classroom Restructuring: What Do Teachers Really Need? Educational Technology Research and Development, 40(3), 95-111.	Cognitive apprenticeship (Brown et al., 1989) provides a second basis for the design of STF. The teacher in the STF video models the effective teaching behavior. Further, reflections by that teacher and other experts help to focus attention on relevant aspects of the teaching approach. As the apprentice teacher tries the strategies demonstrated, he or she can return to the STF video to compare performances.
Brown, Collins & Duquid (1989)	Fishman, B. & Duffy, T. (1992). Classroom Restructuring: What Do Teachers Really Need? Educational Technology Research and Development, 40(3), 95-111.	The theoretical basis for STF's design is informed by the growing research in cognitive psychology and constructivist pedagogy. The approach of STF is based on the assumption that teaching is an integrated activity. While the parts can be understood separately, the teacher must have an integrated model of what he or she is trying to do in the classroom in order to achieve a unified whole. This is a reflection of current theories on domain-dependent learning (Bednar, Cunningham, Duffy, & Perry, 1991; Brown, Collins, & Duguid, 1989; Duffy & Jonassen, 1991).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Brown, Collins & Duquid (1989)	Gagne, R. & Merrill, M. (1990). Integrative Goals for Instructional Design. Educational Technology Research and Development, 38(1),23-30.	When instruction is considered in the more comprehensive sense of a module, section, or course, it becomes apparent that multiple objectives commonly occur. A student seldom learns about the legislative powers vested in Congress in isolation. Usually the module or section of the course is concerned with the way Congress operates to make laws. Not only are new facts introduced, but new concepts must be acquired, and new principles of government understood. Polynomial expressions must be seen to be subject not only to the procedure of addition, but also to those of decomposition, and in the context of real world problems for which these mathematical operations provide a solution tool (Brown, Collins, & Duguid, 1989). A lesson on as familiar a subject as plant growth may readily involve verbal information concerning plant names and varieties, the concept of plant parts, and some rules about plant growth. When the comprehensiveness of topics reaches a level such as often occurs in practice, instructional design is forced to deal with multiple objectives and the relationship among these objectives.
Brown, Collins & Duquid (1989)	Gerber, S. & Scott, L. (2007). Designing a Learning Curriculum and Technology's Role in it. Educational Technlogy Research and Development, 55(5), 461-478.	From this perspective, the role of the educational research curriculum is to provide opportunities for the students to begin to see, think, and talk about the world as educational researchers do (Brown, Collins, & Duguid, 1989; Bruner, 1996; Dewey, 1910; Lave & Wenger, 1991; Salomon, 2002; Wenger, 1998).
Brown, Collins & Duquid (1989)	Gerber, S. & Scott, L. (2007). Designing a Learning Curriculum and Technology's Role in it. Educational Technlogy Research and Development, 55(5), 461-478.	That is, the classroom would be a place to which the students would bring their everyday, JPF, notions of and experiences with research. Working with these experiences would show the students ''the legitimacy of their implicit knowledge and its availability as scaffolding in apparently unfamiliar tasks'' (Brown, Collins, & Duguid, p.38).
Brown, Collins & Duquid (1989)	Gerber, S. & Scott, L. (2007). Designing a Learning Curriculum and Technology's Role in it. Educational Technlogy Research and Development, 55(5), 461-478.	Awareness that the behavior of apprentices and that of ''Just Plain Folks'' (JPFs) are qualitatively similar in that people are constantly adopting the behavior and belief systems of their peers (Brown et al., 1989) helped to guide our planning.
Brown, Collins & Duquid (1989)	Johari, A. & Bradshaw, A. (2008). Project-Based Learning in an Internship Program: A Qualitative Study of Related Roles and Their Motivational Attributes. Educational Technology Research and Development, 56(3), 329-359.	Students use multiple sources of information, including other individuals, when they confront problems in complex real situations (Brown, Collins, & Duguid, 1989; Resnick, 1987).
Brown, Collins & Duquid (1989)	Kapur, M. & Kinzer, C. (2007). Examining the Effect of Problem Type in a Synchronous Computer-Supported Collaborative Learning (CSCL) Environment. Educational Technology Research and Development, 55(5), 439-459.	Situative, socio-constructivist theories of learning emphasize the importance of having learners engage in contextualized, authentic, ill-structured activities for any meaningful learning to take place (Brown, Collins, & Duguid, 1989; Scardamalia & Bereiter, 2003).
Brown, Collins & Duquid (1989)	Kapur, M. & Kinzer, C. (2007). Examining the Effect of Problem Type in a Synchronous Computer-Supported Collaborative Learning (CSCL) Environment. Educational Technology Research and Development, 55(5), 439-459.	Situated and socio-constructivist theories of learning and collaboration strongly advocate problem solving to be authentic and ill-structured for meaningful learning to take place (Brown et al., 1989; Scardamalia & Bereiter, 2003).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Brown, Collins & Duquid (1989)	Orey, M. & Nelson, W. (1993). Development Principles for Intelligent Tutoring Systems: Integrating Cognitive Theory into the Development of Computer-Based Instruction. Educational Technology Research and Development, 41(1), 59-72.	While these strategies are not significantly different from those already employed in some CBI, the use of strategies based in real-world contexts (Bransford, Sherwood, Hasselbring, Kinzer, & Williams, 1991; Brown, Collins, & Duguid, 1989) and case-based instruction (Spiro & Jehng, 1991) is becoming an important factor in the development of new uses of computers for instruction. S
Brown, Collins & Duquid (1989)	Plass, J. & Salisbury, M. (2002). A Living-Systems Design Model for Web-based Knowledge Management Systems. Educational Technology Research and Development, 50(1), 35-56.	A number of unresolved issues remain for the KM system that was implemented based on the design model described in this article. A first issue is that more research has to be conducted with regard to the instructional components of the system. For example, the living-systems approach is designed to provide more explicit support for facilitating situated learning (Brown, Collins, & Duguid, 1989) than found in traditional ISD approaches.
Brown, Collins & Duquid (1989)	Reeves, T., Herrington, J., & Oliver, R. (2004). A Development Research Agenda for Online Collaborative Learning. Educational Technology Research and Development, 52(4), 53-65.	Authentic tasks must be ill defined, requiring students to define the tasks and subtasks needed to complete the activity (e.g., Bransford, Vye, Kinzer, & Risko, 1990; Brown et al., 1989; Cognition & Technology Group at Vanderbilt, 1990a; Winn, 1993; Young, 1993).
Brown, Collins & Duquid (1989)	Reeves, T., Herrington, J., & Oliver, R. (2004). A Development Research Agenda for Online Collaborative Learning. Educational Technology Research and Development, 52(4), 53-65.	Herrington et al. (2003) have defined ten design principles for developing and evaluating this type of authentic task-based collaborative learning environment: 1. Authentic tasks must have real-world relevance (e.g., Brown, Collins, & Duguid, 1989; Cognition and Technology Group at Vanderbilt, 1990a; Jonassen, 1991; Resnick, 1987; Winn, 1993; Young, 1993).
Brown, Collins & Duquid (1989)	Reeves, T., Herrington, J., & Oliver, R. (2004). A Development Research Agenda for Online Collaborative Learning. Educational Technology Research and Development, 52(4), 53-65.	Weigel (2002) described another innovative model for online courses that takes advantage of the pedagogical affordances of online learning based on advances in situated learning theory (Brown et al., 1989). He recommended the construction of virtual, collaborative spaces, called "knowledge rooms" where learners can engage in "deep learning," that is, "learning that promotes the development of conditionalized knowledge and metacognition through communities of inquiry" (p. 5).
Brown, Collins & Duquid (1989)	Young, M. (1993). Instructional Design for Situated Learning. Educational Technology Research and Development, 41(1), 43-58.	*Brown et al.* suggested that cognitive apprenticeships can be designed that immerse students in the culture of traditional academic domains such as mathematics, science, history, art, music, and languages. By being immersed in such realistic contexts, the need to learn certain repetitive or tedious skills is made evident, thus requiring less direct explanation by the teacher.
Brown, Collins & Duquid (1989)	Young, M. (1993). Instructional Design for Situated Learning. Educational Technology Research and Development, 41(1), 43-58.	Brown, Collins, and Duguid (1989) have suggested that learning should take place in the context of realistic settings in which the reasons for learning sometimes repetitive or tedious procedures are made clear--an idea with roots tracing back to experiential learning (Dewey, 1938).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Brown, Collins & Duquid (1989)	Young, M. (1993). Instructional Design for Situated Learning. Educational Technology Research and Development, 41(1), 43-58.	For situated cognition which has social/cultural components, potential invariants of the agent include goals and intentions, and potential regulation includes information contained in the environment, especially other people who provide mutual affordances for each other (e.g., cognitive apprenticeship, Brown et al., 1989; reciprocal teaching, Brown & Palincsar, 1988; distributed intelligence, Pea, 1988; external memory, Wegner, 1987)
Brown, Collins & Duquid (1989)	Young, M. (1993). Instructional Design for Situated Learning. Educational Technology Research and Development, 41(1), 43-58.	Using what Brown et al. (1989) called "authentic tasks" enables students to immerse themselves in the culture of an academic domain, much like an apprentice tailor can be immersed in the culture of tailoring while only being responsible for ironing the garments finished by the master tailor.
Brown, Collins & Duquid (1989)	Young, M. (1993). Instructional Design for Situated Learning. Educational Technology Research and Development, 41(1), 43-58.	When Brown et al. (1989) discussed situated cognition and cognitive apprenticeships, they relied heavily on real-world apprenticeships (e.g., apprentice tailors) as the model for their analysis.
Miller (1956)	Bovy, R. (1981). Successful Instructional Methods: A Cognitive Information Processing Approach. Educational Technology Research and Development, 29(4), 203-217.	Maintenance of information in working memory is primarily a function of active rote rehearsal as well as the meaningfulness of the stimuli. In tests of immediate recall of low meaningful stimuli such as random numbers or letters, typical retention ranges around seven items (Miller, 1956). However, if such individual items as letters, for example, are recombined into larger meaningful units such as words, the learner can recall seven (plus or minus two) of the larger units. Thus, the expression "chunks" has been employed to describe the storage capacity of working memory at around seven chunks of information, each chunk being a function of the meaningfulness of the information.
Miller (1956)	Cates, W. & Goodling, S. (1997). The Relative Effectiveness of Learning Options in Multimedia Computer-Based Fifth-Grade Spelling Instruction. Educational Technology Research and Development, 45(2), 27-46.	Although the actual operational specifics of learning options are discussed later in this article, at this point it is worth noting that we attempted to minimize the confounding influences of differences in program operation and look and feel by standardizing the two programs' designs in four ways. The first standardization was in structure. Both programs employed similar screen layouts (mirror imaged) and placed all gauges, input fields, and displayed messages in equivalent locations. Learning options were arranged in a control strip at the bottom of the main screen of each program, a strip limited to nine options to control cognitive load (Miller, 1956).
Miller (1956)	Clarke, T., Ayres, P., & Sweller, J. (2005). The Impact of Sequencing and Prior Knowledge on Learning Mathematics Through Spreadsheet Applications. Educational Technology Research and Development, 53(3), 15-24.	For the last two decades, CLT has been successfully employed to guide instructional design. A basic assumption of CLT is that interactions between working memory and long-term memory play a significant role in learning. When dealing with novel information, working memory is extremely limited. Humans are only able to store and process a few novel combinations of elements or chunks at any given time (Miller, 1956).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Miller (1956)	Cobb, T. (1997). Cognitive Efficiency: Toward a Revised Theory of Media. Educational Technology Research and Development, 45(4), 21-35.	An answer may even be in sight to Miller's (1956) ancient riddle, that if working memory is confined to seven bits of information then how is complex cognition possible? The answer may lie less with in-the-head strategies (like chunking, automatization, top-down processing, forward reasoning, and skilled memory)...
Miller (1956)	Dwyer, F. (1976). The Effect of IQ Level on the Instructional Effectiveness of Black-and-White and Color Illustrations. Educational Technology Research and Development, 24(1), 49-62.	The available evidence (French, 1954; Miller, 1956; Rappaport, 1957; Travers, 1964; Attneave, 1959) seems to indicate that the effectiveness of discrimination learning promoted by the addition of relevant stimuli may be limited by the information processing capacity of the organism with learning reaching an early peak and then diminishing with the addition of relevant, but superfluous, cues.
Miller (1956)	Goldstein, E. (1975). The Perception of Multiple Images. Educational Technology Research and Development, 23(1), 34-68.	The above ideas are especially relevant to, Miller's (1956) ideas regarding how information should be specified. He argues that information should be defined in terms of the units that the perceiver uses for a particular task. So, the specification of information (and the accompanying scanning rate) really depends on the level of analysis required in a specific situation.
Miller (1956)	Grover Jr, P. (1974). Effect of Varied Stimulus Complexity and Duration upon Immediate Recall of Visual Material in a Serial Learning Task. Educational Technology Research and Development, 22(4), 439-452.	The materials, as shown in Figures 1 and 2, were designed to train students in serial learning tasks consisting of the recall of both simple and complex stimuli at varying rates of stimulus duration. The treatment series were composed of line drawings of common objects which were: a) within the fourth-grade students' verbal and visual vocabularies, b) readily discriminated, and c) easily described by a single concept. They were representative of visual instructional materials at the elementary level as determined by a review of basal readers and work books. Following the selection of 20 objects on the above criteria, colors (brown, blue, yellow, purple, gray, red, green) selected by the same criteria were assigned to ten of the objects at random. Colors were used to create two series (practice and treatment) of complex images requiring the recall of two concept labels (name of object and color) per image. The remaining ten images, black-and-white line drawings, were used to create two series (practice and treatment) of simple images that required only the recall of the name of the object pictured. The length of the treatment series was set at seven images, because previous research (Miller, 1956) indicated this is the average adult memory span. The order of presentation of the stimulus pictures within the simple and complex series was the same for all stimulus durations.
Miller (1956)	Hannafin, M. & Rieber, L. (1989). Psychological Foundations of Instructional Design for Emerging Computer-Based Instructional Technologies: Part 1. Educational Technology Research and Development, 37(2), 91-101.	shortterm memory (STM), also referred to as working memory. STM acts essentially as a transitional buffer containing information units to be acted upon. It does not, by itself, support permanent storage, but instead selectively regulates the exchange of information among ongoing instruction, prior knowledge, and long-term storage of lesson informarion. Due to its transitional nature, STM has limited capacity, generally estimated to be seven (plus or minus 2) informational or idea units (Miller, 1956).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Miller (1956)	Hsia, H. (1968). On Channel Effectiveness. Educational Technology Research and Development, 16(3), 245-267.	Since man's IPC is known under specified conditions (Attneave, ~959; Luce, 196o; Miller, :1956; Quastler, :r955), i.e., between 2 to 4 bits/sec, of information, the theoretical optimal rate of AV presentation can be ascertained. Thus, it appears that the superiority of AV over A or V almost entirely depends upon the amounts of transmitted information, i.e., input.
Miller (1956)	Hsia, H. (1968). On Channel Effectiveness. Educational Technology Research and Development, 16(3), 245-267.	Man's empirical IPC has been extensively reviewed by many authors (Attneave, 1959; Cherry, 196x; Luce, x96o; Miller, 1956; Pierce, ~96i; Quastler, ~955).
Miller (1956)	Hsia, H. (1968). On Channel Effectiveness. Educational Technology Research and Development, 16(3), 245-267.	Each of these studies found that if the information needed to be processed is of very low amount and is repeated frequently enough, then learning will result. It has been found, for example, in the Egorov study and in Smith's Ebbinghausian study (Miller, 1956) that the effects of practice and training usually increase learning but not necessarily improve the capacity for learning, indicating a necessary distinction between the IPC and IP rate.
Miller (1956)	Hsia, H. (1971). The Information Processing Capacity of Modality and Channel Performance. Educational Technology Research and Development, 19(1), 51-75.	Fortunately man's information processing capacity is quite stable. In summarizing many studies, Frick (x953) states that man's discriminative capacity rate appears to be relatively fixed between two and three bits/sec, which corresponds to "the magical number seven, plus or minus two" eloquently expounded by G. A. Miller (1956). In other words, man's information handling capacity is within the range of five to nine elements or units at a time.
Miller (1956)	Hsia, H. (1971). The Information Processing Capacity of Modality and Channel Performance. Educational Technology Research and Development, 19(1), 51-75.	Miscellaneous Information Processing Capacities Under Various Conditions Absolute Judgment 1 2.5-7.2 Miller, 1956
Miller (1956)	Hsia, H. (1971). The Information Processing Capacity of Modality and Channel Performance. Educational Technology Research and Development, 19(1), 51-75.	In considering the differences among the A, V, and central nervous system information processing capacity (Jacobson,195o, 195~; G. Miller, 1956), a communication model which takes into account redundancy, equivocation, noise, and information (Hsia, z968b) in terms of bisensory information processing can be examined. It should be noted that the information processing mechanism does not operate by random selection. The information processed by either modality is selected and filtered before entering into the A or V system, or both, and is filtered again before entering the central nervous system. A tremendous amount of information is discarded at the entrance of modalities and the central nervous system. In addition to the filtering of information, a large portion of redundancy, including stimulus and betweenchannel redundancy, is also eliminated along with some noise that can be discriminated.
Miller (1956)	Huang-Yao, H. & Sullivan, F. (2009). Towards an Idea-Centered, Principle-Based Design Approach to Support Learning as Knowledge Creation. Educational Technology Research and Development, 57(5), 613-627.	Such a process is commonly associated with cognitive mechanisms such as chunking (Miller 1956), schemas (Anderson 2000) and scripts (Schank and Abelson 1977).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Miller (1956)	Hueyching, J. & Reeves, T. (1992). Mental Models: A Research Focus for Interactive Learning Systems. Educational Technology Research and Development, 40(3), 39-53.	The limited capacity of working memory to hold only five to nine chunks of information simultaneously (Miller, 1956) makes it difficult for users of complexly structured ILS to reason when numerous cognitive load factors must be handled at once.
Miller (1956)	Kalyuga, S. & Sweller, J. (2005). Rapid Dynamic Assessment of Expertise to Improve the Efficiency of Adaptive E-learning. Educational Technology Research and Development, 53(3), 83-93.	Processing limitations of human working memory are known to be a major factor influencing the effectiveness of instructional presentations. A limited working memory capacity could easily be overloaded if more than a few chunks of information are processed at the same time (e.g., Baddeley, 1986; Miller, 1956).
Miller (1956)	Leslie, K., Low, R., Putai, J., & Sweller, J. (2012). Redundancy and Expertise Reversal Effects when Using Educational Technology to Learn Primary School Science. Educational Technology Research and Development, 60(1), 1-13.	atural information processing systems include a large information store, long-term memory in the case of human cognition and processes to deal with novel information without destroying the information store, handled by a working memory that is very limited in capacity (Miller 1956) and duration (Peterson and Peterson 1959).
Miller (1956)	Pastore, R. (2010). The Effects of Diagrams and Time-Compressed Instruction on Learning and Learners' Perceptions of Cognitive Load. Educational Technology Research and Development, 58(5), 485-505.	According to Miller (1956), we can store seven units of information, plus or minus two, in our short-term memory at any one time depending on how meaningful the information is to the learner.
Miller (1956)	Pociask, F. & Morrison, G. (2008). Controlling Split Attention and Redundancy in Physical Therapy Instruction. Educational Technology Research and Development, 56(4), 379-399.	Miller (1956) established that working memory can only maintain about seven elements of information at a time.
Miller (1956)	Pociask, F. & Morrison, G. (2008). Controlling Split Attention and Redundancy in Physical Therapy Instruction. Educational Technology Research and Development, 56(4), 379-399.	In practical terms, human working memory is increasingly prone to error as the learning task becomes more complex, and under typical circumstances, can only hold elements active in working memory for a matter of seconds without rehearsal (Anderson et al. 1996; Baddeley 1992a; Miller 1956; Shiffrin and Nosofsky 1994).
Miller (1956)	Randhawa, B. (1971). Intellectual Development and the Ability to Process Visual and Verbal Information. Educational Technology Research and Development, 19(3), 298-312.	How much information does a child process from the visual and the auditory world? This problem has its historic roots in Wundt's (~912) study of sensory perception. He found that the span of consciousness was z6, or eight pairs of clicks when the clicks were grouped in pairs. However, this span could be enlarged to 4 ~ clicks at one time for a more complicated rhythmic pattern. Numerous published studies on digit span suggest a limit on the number of digits that can be processed by normal individuals. Miller (1956) generalized the case to include making judgments of length, time, etc., and concluded that the limit of capacity for processing information was seven plus or minus two. Chomsky (~965) points out the limits of erabeddings one can process in grammar, a limit set not by the rules of grammar but by the memory span of the listeners. This study is concerned with the extent to which the capacity for information processing by the child increases in amount with development.

Sample Seminal Publication	Citing ETRD Article	Citation Context
Miller (1956)	Rittschof, K. (2010). Field Dependence–Independence as Visuospatial and Executive Functioning in Working Memory: Implications for Instructional Systems Design and Research. Educational Technology Research and Development, 58(1), 99-114.	According to van Merrie¨nboer and Sweller (2005), central to CLT is that our working memory can store only about seven elements of novel information at any time (Miller 1956) while operating on about two to four of those elements.
Miller (1956)	Rossiter Jr, C. (1971). Rate-of-Presentation Effects on Recall of Facts and of Ideas and on Generation of Inferences. Educational Technology Research and Development, 19(3), 313-324.	As noted earlier, the speed of presentation cannot be increased indefinitely without some decline in listening test scores. At this point information theorists would say that the capacity of the receiver has been exceeded (Miller, 1956) so that he may comprehend only some aspects of the message while missing others. The listener in this situation must selectively attend to only some portions of the message if he is to comprehend any of it at all. In working toward a better understanding of listening comprehension of compressed speech, it is desirable to know whether various types of information are systematically missed as rate of presentation is increased. If more compressed speech is to be put to practical uses, it is important to know which types of information are most amenable to compression with minimal losses in listener information gain. Furthermore, it might be reasonable to assume that if the different types of information are not equally suitable to compression, then they might not be equally suited to the oral communication situation in general. In an attempt to determine the relative suitability of the three types of information for compression and the oral communication situation in general, a second major purpose of the study was to test the hypothesis of no significant interaction between type of information and speed of presentation
Miller (1956)	Schmid, R. & Gerlach, V. (1986). An Analysis of Algorithmic Processes and Instructional Design. Educational Technology Research and Development, 34(3), 163-174.	The composition and structure of the algorithm is another malleable factor in the hands of the designer. For example, Scandura (1977) and Gerlach et al. (1975) have provided many examples of how solution procedures for a single, given problem can vary in terms of configuration (location of operators and discriminators), but all versions produce the correct results. An algorithm for a given task may be a strict, sequential procedure, as in intellectual or motor skills (e.g., cooking, conducting a statistical analysis, administering a standardized test). In such cases, the few decisions made are relatively unambiguous, and job aids are often the most effective means of teaching. However, flexibility is introduced when discriminators ask for in-. creasingly complex (or heuristic) decisions (e.g., selecting the correct statistical test, identifying prerequisites during an instructional analysis, ~ouble-shootlng an overheating problem in a refinery process). Again, first ensure that each step is elementary to the target population. Then consider the depth and width of the algorithm produced. If it is to be learned (memorized), its initial width and depth should not exceed five to seven (Miller, 1956).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Miller (1956)	Schmid, R. & Gerlach, V. (1986). An Analysis of Algorithmic Processes and Instructional Design. Educational Technology Research and Development, 34(3), 163-174.	Given these learner preferences, limitations imposed by memory load seem to suggest that an algorithm's depth should not exceed 5-7 (Miller, 1956; Schmid & Gerlach, 1977).
Miller (1956)	Silber, K. (1998). The Cognitive Approach to Training Development: A Practitioner's Assessment. Educational Technology Research and Development, 46(4), 58-72.	A fact is a simple association among a set of verbal and/or visual propositions. When one knows a fact, one has placed it in a structure, so one can recall it from memory. Learning facts as part of a structure that will help one recall them in the way one needs is much more efficient than trying to memorize each fact by itself. Knowing a fact does not mean one can generalize it to new situations, explain what it means, identify its relationship to other facts, or apply it to do anything. Some examples of facts are: • on a traffic light, red means stop, green means go, yellow means prepare to stop • in 1492 Christopher Columbus headed from Spain, and landed in the Caribbean; he was not the first to do so, nor did he discover America • Miller's (1956) study for Bell Labs demonstrated that the largest number of digits a person could remember easily was 7; • the 5 steps to create a table in MS Word 6.0 for Windows 95 are: (a) select tables, (b) select number of rows, (c) select number of columns, (d) select line appearance, (e) click OK
Miller (1956)	Silber, K. (1998). The Cognitive Approach to Training Development: A Practitioner's Assessment. Educational Technology Research and Development, 46(4), 58-72.	How memory records are represented in memory. Chunking. Memories are stored, not as individual bits or as long strings of information, but rather as chunks, with each chunk containing a few elements (three to seven, depending on the theorist). As indicated earlier, what an element is and what a chunk is differ, based on the learner's existing knowledge. (Miller, 1956)
Miller (1956)	Silber, K. (1998). The Cognitive Approach to Training Development: A Practitioner's Assessment. Educational Technology Research and Development, 46(4), 58-72.	Limited capacity. Whether there are one or two types of memory, there still seems to be a limit on the amount of information we can rehearse at one time. The classic Bell Telephone study (Miller, 1956) showing the "magic number of 7 +/- 2 bits" and the phenomenon of "chunking" still seem to apply, with some modifications of how one defines a bit (element) or a chunk.
Miller (1956)	Van Merrienboer, J. & Ayres, P. (2005). Research on Cognitive Load Theory and Its Design Implications for E-Learning. Educational Technology Research and Development, 53(3), 5-13.	CLT (Sweller, 2004) assumes a working memory with a very limited capacity when dealing with novel information, as well as an effectively unlimited long-term memory holding cognitive schemas that vary in their degree of complexity and automation. Working memory capacity is about seven elements for storing information and two to four elements for processing information (Miller, 1956), whereas long-term memory is not subject to the same limitations. Human expertise comes from knowledge stored in cognitive schemas, not from an ability to engage in reasoning with many new elements yet to be organized in long-term memory. It is through the—often conscious and mindful—construction of increasing numbers of ever more complex schemas, and through the automation of some of those schemas, that expertise develops.

Sample Seminal Publication	Citing ETRD Article	Citation Context
Miller (1956)	Zhongmin, L. & Merrill, M. (1991). ID Expert 2.0: Design Theory and Process. Educational Technology Research and Development, 39(2), 53-69.	Compound Content Structure. The previous paragraphs identify some of the basic forms of content structure. In real-world subject matter, these simple forms must be expanded to accommodate the details of the knowledge to be taught. The fundamental principle underlying the elaboration of content structure is the limitation on short-term memory. In order to be remembered and learned efficiently, content must be organized to limit the number of items under consideration at any moment to approximately 7 + 2 (Miller, 1956). This clustering of information enables the student to handle great complexity by "chunking" the information so that there is only a limited amount of information in short-term memory at any one time.
Miller (1956)	Fadde, P. (2009). Instructional Design for Advanced Learners: Training Recognition Skills to Hasten Expertise. Educational Technology Research and Development, 57(3), 359-376.	The researchers concluded that chess experts use chess-specific schema to group pieces into meaningful chunks, thereby circumventing the generally accepted ‘‘seven plus or minus two’’ limitation of working memory (Miller, 1956).
Miller (1956)	Rittschof, K. & Kulhavy, R. (1998). Learning and Remembering from Thematic Maps of Familiar Regions. Educational Technology Research and Development, 46(1), 19-38.	As working memory has a limited processing capacity (Miller, 1956), the efficiency of a thematic map for a given task should determine the effectiveness of the image formed from this map for integrating new information.
Palincsar & Brown (1984)	Bottge, B., Rueda, E., Jung, K., Grant, T., & LaRaque, P. (2009). Assessing and Tracking Students’ Problem Solving Performances in Anchored Learning Environments. Educational Technology Research and Development, 57(4), 529-552.	Solving difficult problems such as the ones in EAI requires extraordinary self-management skills (e.g., metacognition and evaluation) (Glasgow 1997; Hannafin et al. 1997; Palincsar 1986; Palincsar and Brown 1984).
Palincsar & Brown (1984)	Brush, T. & Saye, J. (2000). Implementation and Evaluation of a Student-Centered Learning Unit: A Case Study. Educational Technology Research and Development, 48(3), 79-100.	A second assumption about the student involves self-management, monitoring, and evaluation. In student-centered activities, learners are expected not only to set goals but also to monitor their progress in order to determine if the strategies they are using to accomplish their goals are effective (Glasgow, 1997; Hannafin, Hill, & Land, 1997; Palincsar & Brown, 1984).
Palincsar & Brown (1984)	Brush, T. & Saye, J. (2000). Implementation and Evaluation of a Student-Centered Learning Unit: A Case Study. Educational Technology Research and Development, 48(3), 79-100.	Furthermore, in order for students to actively participate in their own learning they must possess self-monitoring and other metacognitive skills that are not necessarily inherent in every individual (Hannafin, Hill, & Land, 1997; Palincsar & Brown, 1984).
Palincsar & Brown (1984)	Brush, T. & Saye, J. (2000). Implementation and Evaluation of a Student-Centered Learning Unit: A Case Study. Educational Technology Research and Development, 48(3), 79-100.	Thus the scaffold was ineffective in supporting the metacognitive skills so important to problem solving (Palincsar & Brown, 1984; Voss, Greene, Post, & Penner, 1983; Wineburg, 1991).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Palincsar & Brown (1984)	Bulu, S. & Pedersen, S. (2010). Scaffolding Middle School Students' Content Knowledge and Ill-Structured Problem Solving in a Problem-Based Hypermedia Learning Environment. Educational Technology Research and Development, 58(5), 507-529.	For each type of scaffold, domain-general and domain-specific, two levels of support were developed: continuous support and faded support. Continuous scaffolds provided the same level of support in identifying homes for each of the four species of aliens used in this study. Faded scaffolds provided the same level of support as the continuous scaffolds for the first species of aliens, and then gradually reduced support until students received no support for the fourth species. The design of these levels drew heavily from previous work by Lee and Songer (2004). Based on the literature (Palincsar and Brown 1984; Wood et al. 1976), they withdrew the modeled explanations first, the direct content prompts second, and sentence starters last, which resulted in a systematic gradual reduction of support.
Palincsar & Brown (1984)	Bulu, S. & Pedersen, S. (2010). Scaffolding Middle School Students' Content Knowledge and Ill-Structured Problem Solving in a Problem-Based Hypermedia Learning Environment. Educational Technology Research and Development, 58(5), 507-529.	Throughout the literature, scaffolding has been provided in different formats, including technology-based scaffolds (Fretz et al. 2002; Kyza and Edelson 2003; Smith and Reiser 1998), prompt scaffolds (Davis 2003; Ge and Land 2003; King and Rosenshine 1993; Lin and Lehman 1999), peer interaction (Greene and Land 2000; Scardamalia and Bereiter 1992; Webb 1989), and teacher support (Azevedo et al. 2005; Fretz et al. 2002; Palincsar and Brown 1984; Tabak 1999).
Palincsar & Brown (1984)	Chin, D., Dohmen, I., Cheng, B., Oppezzo, M., Chase, C., & Schwarts, D. (2010). Preparing Students for Future Learning with Teachable Agents. Educational Technology Research and Development, 58(6), 649-669.	Research has shown that tutors gain a deeper understanding through interactions with their tutee, when they answer deep questions and respond to misconceptions (Chi et al. 2001; Palincsar and Brown 1984; Uretsi 2000).
Palincsar & Brown (1984)	Hannafin, M., Hannafin, K., Land, S., & Oliver, K. (1997). Grounded Practice and the Design of Constructivist Learning Environments. Educational Technology Research and Development, 45(3), 101-117.	Methods consistent with construcfivist foundations and assumptions typically emphasize teacher-student or student-student interactions to model or scaffold understanding and performance (see, for example, Linn, 1995; Palincsar & Brown, 1984).
Palincsar & Brown (1984)	Johari, A. & Bradshaw, A. (2008). Project-Based Learning in an Internship Program: A Qualitative Study of Related Roles and Their Motivational Attributes. Educational Technology Research and Development, 56(3), 329-359.	By showing past projects, mentors may help interns discover the kinds of skills that would be required from them at work. The online projects also could help them be prepared for a variety of challenges and support feelings of autonomy. The peer discussion meetings support learners in forging informal groups and out-of-class interactions during which they may discuss and discover additional supports, questions, and solutions that they might never bring up during class sessions. Self-directed learning experiences that utilize forms of reciprocal teaching via class discussions have previously been shown to be very effective (Gall, 1984; Palincsar, 1987; Palincsar & Brown, 1984, 1989).
Palincsar & Brown (1984)	Land, S. & Zembal-Saul, C. (2003). Scaffolding Reflection and Articulation of Scientific Explanations in a Data-Rich, Project-Based Learning Environment: An Investigation of Progress Portfolio. Educational Technology Research and Development, 51(4), 65-84.	Over the past decade, researchers have been investigating the role of instructional "scaffolds," or support devices, to facilitate comprehension of complex tasks (Brown, 1992; Palincsar & Brown, 1984).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Palincsar & Brown (1984)	Land, S. & Zembal-Saul, C. (2003). Scaffolding Reflection and Articulation of Scientific Explanations in a Data-Rich, Project-Based Learning Environment: An Investigation of Progress Portfolio. Educational Technology Research and Development, 51(4), 65-84.	Palincsar and Brown (1984) used reciprocal teaching methods whereby a teacher models key monitoring strategies such as summarizing, questioning, predicting, and clarifying, and then scaffolds students to take turns leading a dialogue using these strategies.
Palincsar & Brown (1984)	Land, S. (2000). Cognitive Requirements for Learning with Open-Ended Learning Environments. Educational Technology Research and Development, 48(3), 61-78.	Embed scaffolds directly into technology interface to prompt and model the reflective process. Salomon, Globerson, and Guterman (1989) extended Palincsar and Brown's (1984) work with dialogue and reading comprehension strategies to consider the functions of computer technology to afford similar guidance.
Palincsar & Brown (1984)	Land, S. (2000). Cognitive Requirements for Learning with Open-Ended Learning Environments. Educational Technology Research and Development, 48(3), 61-78.	The significance of dialogue during complex learning is longstanding and is often illustrated with Palincsar & Brown's (1984) work on reciprocal teaching. Their approach relies on teacher modeling and dialogue to guide students to learn reading comprehension strategies both independently and with each other.
Palincsar & Brown (1984)	Lubin, I. & Xun, G. (2012). Investigating the Influences of a LEAPS Model on Preservice Teachers' Problem Solving, Metacognition, and Motivation in an Educational Technology Course. Educational Technology Research and Development, 60(2), 239-270.	Design-based researchers (Palincsar and Brown 1984; Brown 1992) have recommended treating learning environments as holistic and complex systems, and so, we viewed both the LEAPS and traditional learning environments as naturalistic and authentically bounded systems.
Palincsar & Brown (1984)	Manu, K. & Kinzer, C. (2007). Examining the Effect of Problem Type in a Synchronous Computer-Supported Collaborative Learning (CSCL) Environment. Educational Technology Research and Development, 55(5), 439-459.	Likewise, instead of scaffolding the entire process of problem solving using process scaffolds, it may only be necessary to scaffold how a group analyzes and frames the problem and then fade the scaffolds (Palincsar & Brown, 1984).
Palincsar & Brown (1984)	Manu, K. & Kinzer, C. (2007). Examining the Effect of Problem Type in a Synchronous Computer-Supported Collaborative Learning (CSCL) Environment. Educational Technology Research and Development, 55(5), 439-459.	Therein lies the need for more research investigating the effects problem structuredness on collaborative problem-solving interactions and outcomes. Once we come to understand what these differences are, we may be better positioned to design process scaffolds and supports for problem-solving CSCL groups (Palincsar & Brown, 1984)
Palincsar & Brown (1984)	Osman, M. & Hannafin, M. (1992). Metacognition Research and Theory: Analysis and Implications for Instructional Design. Educational Technology Research and Development, 40(2), 83-99.	In reciprocal teaching, several strategies (e.g., summarizing, questioning, clarifying, and predicting) are embedded in a natural dialogue. The teacher and students take turns leading the dialogue and giving feedback to one another (Palincsar & Brown, 1984), providing dynamic models of strategies for monitoring and enhancing comprehension.
Palincsar & Brown (1984)	Osman, M. & Hannafin, M. (1992). Metacognition Research and Theory: Analysis and Implications for Instructional Design. Educational Technology Research and Development, 40(2), 83-99.	The learner is tacitly viewed as a passive participant who responds to instruction but does not fully understand, or is not consciously aware of, the activities provided for use (Palincsar & Brown, 1984).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Palincsar & Brown (1984)	Saye, J. & Brush, T. (2002). Scaffolding Critical Reasoning About History and Social Issues in Multimedia-Supported Learning Environments. Educational Technology Research and Development, 50(3), 77-96.	Furthermore, unlike novices, experts employ metacognitive strategies that allow them to manage their thinking and apply effectively the knowledge that they possess (Palincsar & Brown, 1984; VanSickle & Hoge, 1991).
Palincsar & Brown (1984)	Shapiro, A. (2008). Hypermedia Design as Learner Scaffolding. Educational Technology Research and Development, 56(1), 29-44.	When prior knowledge is integrated with the text base, resulting in the situation model, learning is more robust and a deeper level of understanding is achieved. A well established body of research has shown that a number of cognitive factors mediate the creation of situation models, and successful learning in general. Among the most important are prior knowledge (see Dochy et al. 1999; Shapiro 2004) and metacognition (e.g., Brown 1982; Oakhill and Yuill 1996; Palincsar and Brown 1984).
Palincsar & Brown (1984)	Wilson, B. & Cole, P. (1991). A Review of Cognitive Teaching Models. Educational Technology Research and Development, 39(4), 47-64.	Brown and Palincsar (1989; Palincsar & Brown, 1984) have developed a cooperative learning system for the teaching of reading, termed reciprocal teaching. The teacher and learners assemble in groups of 2 to 7 and read a paragraph together silently. A person assumes the "teacher" role and formulates a question on the paragraph. This question is addressed by the group, whose members are playing roles of "producer" and "critic" simultaneously. The "teacher" advances a summary and makes a prediction or clarification, if any is needed. The role of teacher then rotates, and the group proceeds to the next paragraph in the text. Brown and colleagues have also developed a method of assessment, called dynamic assessment, based on successively increasing prompts on a realistic reading task. The reciprocal teaching method uses a combination of modeling, coaching, scaffolding, and fading to achieve impressive results, with learners showing dramatic gains in comprehension, retention, and far transfer over sustained periods.
Palincsar & Brown (1984)	Xiaodong, L., Hmelo, C., Kinzer, C., & Secules, T. (1999). Designing Technology to Support Reflection. Educational Technology Research and Development, 47(3), 43-62.	From our review of the literature, we identified four types of design features that provide scaffolds for reflective thinking and that can be integrated into video, the Internet, and large telecommunication systems: 1. Process displays: displaying problem-solving and thinking processes; 2. Process prompts: prompting students' attention to specific aspects of processes while learning is in action; 3. Process models: modeling of experts' thinkmg processes that are usually tacit so that students can compare and contrast with their own process in action; 4 Reflective social discourse: creating communitybased discourse to provide multiple perspectives and feedback that can be used for reflection. These four types of scaffolding represent effective instructional strategies that support various forms of reflection in subject domains such as reading, writing, biology, and mathematics (King, 1991; Lin & Lehman, in press; Palincsar & Brown, 1984; Scardamalia & Bereiter, 1985).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Palincsar & Brown (1984)	Xiaodong, L., Hmelo, C., Kinzer, C., & Secules, T. (1999). Designing Technology to Support Reflection. Educational Technology Research and Development, 47(3), 43-62.	For example, when reading articles that are relevant to their research, students engage in reciprocal teaching, which organizes their reflection about what they understand and what they do not understand (see Palincsar & Brown, 1984).
Palincsar & Brown (1984)	Xun, G. & Land, S. (2004). A Conceptual Framework for Scaffolding Ill-Structured Problem-Solving Processes Using Question Prompts and Peer Interactions. Educational Technology Research and Development, 52(2), 5-22.	Peer interaction is a form of collaborative learning that has been studied extensively over the past few decades (e.g., Brown & Palincsar, 1989; Johnson & Johnson, 1994; Palincsar & Brown, 1984; Slavin, 1995).
Palincsar & Brown (1984)	Xun, G. & Land, S. (2004). A Conceptual Framework for Scaffolding Ill-Structured Problem-Solving Processes Using Question Prompts and Peer Interactions. Educational Technology Research and Development, 52(2), 5-22.	Rosenshine and Meister (1992) and Rosenshine, Meister, and Chapman (1996) noted that scaffolds may be tools, such as cue cards or procedural prompts (Scardamalia & Bereiter, 1985; Scardamalia, Bereiter, & Steinbach, 1984), or techniques, such as reciprocal teaching (Palincsar & Brown, 1984), or guided peer questioning (King, 1991; 1992; 1994; King & Rosenshine, 1993).
Palincsar & Brown (1984)	Xun, G. & Land, S. (2004). A Conceptual Framework for Scaffolding Ill-Structured Problem-Solving Processes Using Question Prompts and Peer Interactions. Educational Technology Research and Development, 52(2), 5-22.	For a teacher to best aid the learner to work through a difficult task and attain a higher level in the zone of proximal development, Palincsar and Brown (1984) and Palincsar (1986) using instructional procedures as “scaffolds” to enable students to solve a problem, carry out a task, or achieve a goal that would be beyond their unassisted efforts.
Palincsar & Brown (1984)	Xun, G. & Land, S. (2004). A Conceptual Framework for Scaffolding Ill-Structured Problem-Solving Processes Using Question Prompts and Peer Interactions. Educational Technology Research and Development, 52(2), 5-22.	Prior research has shown support for the effectiveness of those scaffolding techniques for various tasks and processes such as writing (Scardamalia et al., 1984), reading comprehension (King, 1989; Palincsar & Brown), word-problem solving (King, 1991), and knowledge construction (King & Rosenshine).
Palincsar & Brown (1984)	Xun, G. & Land, S. (2004). A Conceptual Framework for Scaffolding Ill-Structured Problem-Solving Processes Using Question Prompts and Peer Interactions. Educational Technology Research and Development, 52(2), 5-22.	Some of the structuring strategies for peer interactions are (a) scripted cooperation (see O’Donnell, 1999, for review), which specifies particular cognitive roles and activities of students and directs them into a specified sequence of discourse, such as summarizing, error feedback, and feedback; (b) reciprocal teaching (Palincsar & Brown, 1984), in which a teacher models and engages student in structured interaction to promote specific discourse such as questioning, summarizing, clarifying, and predicting; and (c) guided peer questioning (King, 1991, 1992, 1994), a procedure used to train group members to ask thought-provoking questions and provide elaborated responses by using structured question prompts.

Sample Seminal Publication	Citing ETRD Article	Citation Context
Palincsar & Brown (1984)	Yanghee, K. & Baylor, A. (2006). A Social-Cognitive Framework for Pedagogical Agents as Learning Companions. Educational technology Research and Development, 54(6), 569-596.	Pedagogical agents may help overcome some constraints of and expand functionalities of conventional computer-based environments. Traditionally, computer-based learning environments (e.g., intelligent tutoring systems) have been tailored to meet a student's individual needs, supporting each learner independently when the environments were well designed (Aimeur & Frasson, 1996; Anderson, Corbett, Koedinger, & Pelletier, 1995; Gertner & VanLehn, 2000; Graesser, VanLehn, Rose, Jordan, & Harter, 2001). However, those learning environments typically failed to provide situated social interaction, which is regarded as a significant influence on both learning and motivation (Lave & Wenger, 2001; Palincsar & Brown, 1984; Powell, Aeby, & Carpenter-Aeby, 2003; Vygotsky, Cole, John-Steiner, Scribner, & Souberman, 1978; Wertsch, Minick, & Arns, 1984).
Palincsar & Brown (1984)	Land, S. & Hannafin, M. (1996). A Conceptual Framework for the Development of Theories-in-Action with Open-Ended Learning Environments. Educational Technology Research and Development, 44(3), 37-53.	Another avenue for research involves how theory building and evolving are facilitated or hindered through social facilitation. Cooperative groups, for example, are assumed to promote sharing and the development of understanding (Johnson, Maruyama, Johnson, Nelson, & Skon, 1981; Palincsar & Brown, 1984).
Palincsar & Brown (1984)	Nath, L. & Ross, S. (2001). The Influence of a Peer-Tutoring Training Model for Implementing Cooperative Groupings with Elementary Students. Educational Technology Research and Development, 49(2), 41-56.	Reciprocal teaching, for example, is an instructional procedure employed to teach four comprehension monitoring strategies (Palincsar & Brown, 1984).
Salomon, Perkins & Globerson (1991)	Barab, S., Bowdish, B., & Lawless, K. (1997). Hypermedia Navigation: Profiles of Hypermedia Users. Educational Technology Research and Development, 45(3), 23-41.	However, hypermedia also poses potential problems in that the more open-ended the activities afforded by an environment the more freedom the learner has in becoming or not becoming mindfully engaged (Salomon, Perkins, & Globerson, 1991).
Salomon, Perkins & Globerson (1991)	Barab, S., Bowdish, B., & Lawless, K. (1997). Hypermedia Navigation: Profiles of Hypermedia Users. Educational Technology Research and Development, 45(3), 23-41.	The above discussion suggests that learner control in an open-ended environment carries with it a double-edged sword--the potential to extend the user's performance or to leave the user lost in cyberspace (Salomon et al., 1991).
Salomon, Perkins & Globerson (1991)	Bulu, S. & Pedersen, S. (2010). Scaffolding Middle School Students' Content Knowledge and ill-Structured Problem Solving in a Problem-Based Hypermedia Learning Environment. Educational Technology Research and Development, 58(5), 507-529.	While a scaffold is defined as a temporary support, a cognitive tool is defined as a support that can be used continuously in the learning process (McNeill 2006; Salomon et al. 1991).
Salomon, Perkins & Globerson (1991)	Clark, R. (1994). Media Will Never Influence Learning. Educational Technology Research and Development, 42(2), 21-29.	A few go so far as to claim that new "intelligence" might be possible as a result of exposure to these attributes (for example, Salomon, Perkins & Globerson, 1991).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Salomon, Perkins & Globerson (1991)	Hannafin, M. (1992). Emerging Technologies, ISD, and Learning Environments: Critical Perspectives. Educational Technology Research and Development, 40(1), 49-63.	External Research and Development Outside the ISD field, several trends have emerged. Both innovative prototypes and fullscale operational learning systems have flourished. There has been a decided emphasis on creating qualitatively different learning experiences rather than re-hosting older ones. Learning systems are widely viewed as a means rather than an end, especially in educational settings (cf. Salomon, Perkins, & Globerson, 1991). The overriding goals of such systems are to promote application and manipulation of knowledge, not simply to acquire the knowledge itself.
Salomon, Perkins & Globerson (1991)	Jonassen, D., Campbell, J., & Davidson, M. (1994). Learning with Media: Restructuring the Debate. Educational Technology Research and Development, 42(2), 31-39.	Restructuring the Debate: Learning with Media We believe that excessive effort has been expended for the past decade, as evidenced by this debate, arguing about the wrong issue. We recommend restructuring the debate to focus not on the role of media as conveyors and deliverers of the designer's message to a stationary learner at the end of instruction, but rather on how media, however defined, can be used to facilitate knowledge-construction and meaning-making on the part of the learner. Questions about the role of media should focus on the effects of learners' cognitions with technology as opposed to the effects of technology (Salomon, Perkins, & Globerson, 1991)--media as facilitators of constructive learning, rather than the conveyors of instruction.
Salomon, Perkins & Globerson (1991)	Kozma, R. (1994). A Reply: Media and Methods. Educational Technology Research and Development, 42(3), 11-14.	It is time to shift the focus of our research from media as conveyors of methods to media and methods as facilitators of knowledge-construction and meaning-making on the part of learners (Jonassen et al., 1994; Kozma, 1991; Salomon, Perkins, & Globerson, 1991).
Salomon, Perkins & Globerson (1991)	Kozma, R. (1994). Will Media Influence Learning? Reframing the Debate. Educational Technology Research and Development, 42(2), 7-19.	Consequently, we will understand the potential for a relationship between media and learning when we consider it as an interaction between cognitive processes and characteristics of the environment, so mediated (Salomon, 1993; Salomon, Perkins, & Globerson, 1991).
Salomon, Perkins & Globerson (1991)	Land, S. & Hannafin, M. (1996). A Conceptual Framework for the Development of Theories-in-Action with Open-Ended Learning Environments. Educational Technology Research and Development, 44(3), 37-53.	Ideally, learning environments provide resources and tools that engender higher-order conceptual thinking and understanding, rather than "short-circuiting" learning. In a previous example, the spreadsheet was used to support what-if thinking by enabling the testing of various combinations of headwind speed and aircraft design. The tool was used by learners to test complex theoretical concepts in concrete ways. In contrast, many systems generate solutions, but fail to make the underlying principles accessible to the learner. An expert system, for example, may prompt learners to provide the color, hardness, and transparency of a mineral in order to determine its identity. The system can subsequently identify the mineral based on the information entered and rules, but provides neither the means to understand the underlying rules nor the heuristics which must be understood in the absence of the system (Salomon, Perkins, & Globerson, 1991).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Salomon, Perkins & Globerson (1991)	Min, L. & Bera, S. (2005). An Analysis of Cognitive Tool Use Patterns in a Hypermedia Learning Environment. Educational Technology Research and Development, 53(1), 5-21.	Cognitive tools are computer-based tools that can amplify and enhance human cognition, and can serve as partners in cognition to extend human intelligence (Pea, 1985; Salomon, Perkins, & Globerson, 1991).
Salomon, Perkins & Globerson (1991)	Min, L. & Bera, S. (2005). An Analysis of Cognitive Tool Use Patterns in a Hypermedia Learning Environment. Educational Technology Research and Development, 53(1), 5-21.	In short, cognitive tools are instruments that can enhance the cognitive powers of learners during their thinking, problem solving, and learning (Jonassen & Reeves, 1996; Kozma, 1987; Pea, 1985; Salomon et al., 1991).
Salomon, Perkins & Globerson (1991)	Rieber, L. (1995). A Historical Review of Visualization in Human Cognition. Educational Technology Research and Development, 43(1), 45-56.	There are many important implications that one can draw from this review. The trends in multimedia learning environments, especially those that are computer based, are slowly moving from verbal to visual, from analog to digital, and from passive to interactive. The implications for the learning process are more far reaching than media dominance, however, especially when the computer's processing and graphical abilities are considered. As already noted, the computer has the potential to become one of our most important cognitive tools, similar to the way paper and pencil reduced demands on human memory. Highly visual computer-based learning environments, such as Geometer's Sketchpad and Interactive Physics, allow individuals to grapple with sophisticated ideas from math and science in visual ways that are at once both concrete and intuitive. Computers and people ~working closely as partners in cognition have potential for fundamental qualitative changes to how we view human cognition (Salomon et al., 1991).
Salomon, Perkins & Globerson (1991)	Rieber, L. (1995). A Historical Review of Visualization in Human Cognition. Educational Technology Research and Development, 43(1), 45-56.	Just as a hammer extends our ability to perform physical tasks, things that extend our ability to perform cognitive tasks and processes have been referred to as cognitive tools (Salomon, Perkins, & Globerson, 1991).
Salomon, Perkins & Globerson (1991)	Rieber, L. (1996). Seriously Considering Play: Designing Interactive Learning Environments Based on the Blending of Microworlds, Simulations, and Games. Educational Technology Research and Development, 44(2), 43-58.	Given the natural role that play and imita-tion serve to intellectual development, game playing and game designing can also be considered as authentic tasks for children. Researchers have stressed the importance of anchoring, or situating, learning in authentic situations (Brown, Collins & Duguid, 1989; Choi & Hannafin, 1995; Cognition and Technology Group at Vanderbilt, 1990). One benefit is that learners become engaged by the material, invoking a state of mindfulness, in which learners employ nonautomatic, effortful, and metacognitively guided processes (Salomon, Perkins & Globerson, 1991).
Salomon, Perkins & Globerson (1991)	Windschitl, M. (2000). Supporting the Development of Science Inquiry Skills with Special Classes of Software. Educational Technology Research and Development, 48(2), 81-95.	Salomon, Perkins, and Globerson (1991) explain that: The very idea of working with an intelligent tool is (DIRECT QUOTE BELOW. Own Paragraph) based on the assumption that users explore, design, probe, write, or test hypotheses in ways that couple the tool's intelligence with theirs in mindful engagement with the task. It thus follows that only when learners function mindfully will the upgrading of performance while working with a computer tool take place. (p. 4)

Sample Seminal Publication	Citing ETRD Article	Citation Context
Salomon, Perkins & Globerson (1991)	Zacharia, Z., Xenofontos, N., & Manoli, C. (2011). The Effect of two Different Cooperative Approaches on Students' Learning and Practices within the Context of a WebQuest Science Investigation. Educational Technology Research and Development, 59(3), 399-424.	Cognitive scaffolds may structure a task, take over parts of a task or give hints and supporting information for the task. The ultimate goal is to establish an intellectual partnership between the tool (cognitive scaffold) and the learner (Jonassen 2000; Salomon et al. 1991).
Salomon, Perkins & Globerson (1991)	Judson, E. (2010). Improving Technology Literacy: Does it Open Doors to Traditional Content? Educational Technology Research and Development, 58(3), 271-284.	Salomon et al. (1991) describe this as a partnership with technology whereby skills and strategies that can be transferred to other situations are developed. Ideally, the result is an intellectual partnership between the technology and the user that allows the individual to clarify new ideas.
Salomon, Perkins & Globerson (1991)	Judson, E. (2010). Improving Technology Literacy: Does it Open Doors to Traditional Content? Educational Technology Research and Development, 58(3), 271-284.	Although computers and related technology can be used to support all school subjects, students today use computers in schools more for word processing than any other function (Becker 2000). While technology in schools can take on many forms such as probes, digital editing equipment, and MP3 players, it is still the computer and the venerable keyboard that is the chief technological presence in schools. The keyboard interface naturally provides a simple method to word process or process words and it is easy to imagine that students who often use word processing programs might be improving related technology literacy skills. Yet, if it were just a matter of students interacting with word processing software as a means to improve technology literacy, we would expect broad and uniform gains. This did not happen. In fact, the low-gain groups experienced decline in technology literacy and this was paralleled by their retreating NCE scores in language arts. What may be in play is what Salomon et al. (1991) indicated are ways in which individuals can interact with technology; perhaps some students have developed better partnerships with the technology and their technology literacy and language arts skills improve in synch. Why those students, who made greatest gains in technology literacy and significant gains in language arts, did not also make significant gains in mathematics and reading may simply be due to there being less opportunity to mediate mathematics and reading through technology. That is, if gains are made in technology literacy, then gains in traditional content areas would only be expected if students are provided ample opportunity to apply their new technology literacy ability to the content. It is supposed that this occurred for some students with language arts, but due to lack of exposure through technology to mathematics and reading, the same gains were not observed in those content areas.

Sample Seminal Publication	Citing ETRD Article	Citation Context
Sweller, Merreinboer, & Paas (1998)	Baylor, A. (2002). Expanding Preservice Teachers' Metacognitive Awareness of Instructional Planning Through Pedagogical Agents. Educational Technology Research and Development, 50(2), 5-22.	While the two-agent condition was more transforming than the instructivist-only and noagent conditions, it did not lead to the greatest change in perspective, as had been predicted. The fact that the presence of two agents simultaneously was not perceived as the most transforming in terms of a change in perspective could be an issue of cognitive load. As Sweller, van Merriënboer, and Paas suggest (1998), "less is best" in learning situations, indicating that in this case the learners may be too focused during problem solving to process advisements from multiple agents.
Sweller, Merreinboer, & Paas (1998)	Beers, P., Boshuizen, H., Kirschner, P., Gijselaers, W., & Westendorp, J. (2008). Cognitive Load Measurements and Stimulated Recall Interviews for Studying the Effects of Information and Communications Technology. Educational Technology Research and Development, 56(3), 309-328.	Cognitive load measurement was done through self-report of invested mental effort on a nine-points symmetrical scale ranging from very, very low mental effort to very, very high mental effort (Paas et al., 2003). Mental effort refers to the cognitive capacity that is actually allocated to solve the problem and can be considered to reflect the actual cognitive load (Sweller et al., 1998)
Sweller, Merreinboer, & Paas (1998)	Beers, P., Boshuizen, H., Kirschner, P., Gijselaers, W., & Westendorp, J. (2008). Cognitive Load Measurements and Stimulated Recall Interviews for Studying the Effects of Information and Communications Technology. Educational Technology Research and Development, 56(3), 309-328.	Cognitive load theory (Sweller et al., 1998) couples insights on working memory to the design of instruction.
Sweller, Merreinboer, & Paas (1998)	Beers, P., Boshuizen, H., Kirschner, P., Gijselaers, W., & Westendorp, J. (2008). Cognitive Load Measurements and Stimulated Recall Interviews for Studying the Effects of Information and Communications Technology. Educational Technology Research and Development, 56(3), 309-328.	Next, we report on an exploratory study with instruction but without performance constraints that builds on these results, in which cognitive load measurements (Sweller, Van Merrie¨nboer, & Paas, 1998) and stimulated recall interviews were used to study both possible beneficial and adverse effects of the instruction. The cognitive load measurements were used to study whether there were differences in working memory load. The interview data were used to get an impression of the actual cognitive processes of the participants during collaboration, so as to assess whether they were germane or extraneous to the process, and whether they gave insight into the effect mechanisms of the instruction.
Sweller, Merreinboer, & Paas (1998)	Beers, P., Boshuizen, H., Kirschner, P., Gijselaers, W., & Westendorp, J. (2008). Cognitive Load Measurements and Stimulated Recall Interviews for Studying the Effects of Information and Communications Technology. Educational Technology Research and Development, 56(3), 309-328.	The above explanation is very interesting from the point of view of cognitive load theory (Sweller et al. 1998), which emphasizes the limited nature of working memory and its consequences for instruction. For instance, this theory holds that working memory overload can hamper learning, and that instruction should minimize extraneous cognitive load, that is, working memory activity caused by the instruction that does not benefit the learning process. Indeed, having to attend to regulatory activities would cause extraneous cognitive load within our settings. Unfortunately, we did not measure cognitive load.

Sample Seminal Publication	Citing ETRD Article	Citation Context
Sweller, Merreinboer, & Paas (1998)	Beers, P., Boshuizen, H., Kirschner, P., Gijselaers, W., & Westendorp, J. (2008). Cognitive Load Measurements and Stimulated Recall Interviews for Studying the Effects of Information and Communications Technology. Educational Technology Research and Development, 56(3), 309-328.	The more complex the learning matter, and the less prior knowledge of the learner, the higher the associated intrinsic cognitive load (Sweller et al., 1998).
Sweller, Merreinboer, & Paas (1998)	Boot, E., Van Merrienboer, J., & Veerman, A. (2007). Novice and Experienced Instructional Software Developers: Effects on Materials Created with Instructional Software Templates. Educational Technology Research and Development, 55(6), 647-666.	More specifically, it is difficult for domain specialists to implement multimedia instruction for at least three reasons. First, to embed didactical models in instructional software, the design must be quite detailed. For example, feedback on learner actions has to be anticipated beforehand because the developer cannot intervene in the learning process 'on-the-fly' as a teacher can do in a classroom. Second, domain specialists may not be aware of the didactical models that are (implicitly) supported by authoring systems. For example, in a 'drill and practice' or 'learning by doing' setting, simulated environments can offer authentic opportunities for an extensive practice of skills. Or, in a 'mastery learning' setting, decisions with regard to mastery and subsequent measures can be based on a process of continuously, non-intrusive tracking and tracing of learning results. Third, domain specialists must be extremely careful with implementing combinations of different visual and auditory representations. For example, narration may work well for explaining a systempaced streaming animation but be less effective than a visual explanation if the learner is able to set the pace of the animation (for more examples, see Mayer, 2001; Sweller, van Merrie¨nboer, & Paas, 1998).
Sweller, Merreinboer, & Paas (1998)	Cheon, J. & Grant, M. (2012). The Effects of Metaphorical Interface on Germane Cognitive Load in Web-based Instruction. Educational Technology Research and Development, 60(3), 399-420.	The assumption is that learners invest their mental effort to enhance their understanding of learning contents (Gerjets et al. 2004; Moreno 2004; Renkl et al. 2004; Sweller et al. 1998; van Merrienboer and Sweller 2005).
Sweller, Merreinboer, & Paas (1998)	Cheon, J. & Grant, M. (2012). The Effects of Metaphorical Interface on Germane Cognitive Load in Web-based Instruction. Educational Technology Research and Development, 60(3), 399-420.	Cognitive load theory distinguishes three types of cognitive load: (a) intrinsic cognitive load as an inherent cognitive resource caused by the complexity of learning content, (b) extraneous cognitive load as an irrelevant cognitive resource caused by the medium, layout or structure of instruction, and (c) germane cognitive load as a relevant cognitive resource caused by the learner's investment on schema construction and automation (Cheon and Grant in press; Sweller et al. 1998; van Merrienboer and Ayres 2005).
Sweller, Merreinboer, & Paas (1998)	Cheon, J. & Grant, M. (2012). The Effects of Metaphorical Interface on Germane Cognitive Load in Web-based Instruction. Educational Technology Research and Development, 60(3), 399-420.	Current cognitive load theory does not specify the relationship between prior knowledge and germane cognitive load. Instead, the theory states that higher intrinsic load yields limited space for germane cognitive load (Sweller et al. 1998; van Merrienboer and Sweller 2005).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Sweller, Merreinboer, & Paas (1998)	Clarke, T., Ayres, P., & Sweller, J. (2005). The Impact of Sequencing and Prior Knowledge on Learning Mathematics Through Spreadsheet Applications. Educational Technology Research and Development, 53(3), 15-24.	CLT researchers have identified three sources of cognitive load during instruction: Intrinsic, extraneous and germane cognitive load (see Paas, Renkl et al., 2003; Sweller et al., 1998). Intrinsic cognitive load is load placed on working memory by the intrinsic nature of the materials to be learnt. Extraneous cognitive load is the load placed on working memory by the instructional design itself and germane cognitive load is the load evoked by the instructional materials that assist the process of schema formation. Whereas germane cognitive load is considered positive because working memory resources are directly focused on learning, the other two forms of cognitive load can seriously impede learning.
Sweller, Merreinboer, & Paas (1998)	Clarke, T., Ayres, P., & Sweller, J. (2005). The Impact of Sequencing and Prior Knowledge on Learning Mathematics Through Spreadsheet Applications. Educational Technology Research and Development, 53(3), 15-24.	Cognitive load theorists argue that overloading working memory inhibits learning, and consequently, instructional procedures are most effective when unnecessary cognitive load is kept to a minimum (for a more detailed discussion see Sweller, 2003; Sweller et al., 1998).
Sweller, Merreinboer, & Paas (1998)	Clarke, T., Ayres, P., & Sweller, J. (2005). The Impact of Sequencing and Prior Knowledge on Learning Mathematics Through Spreadsheet Applications. Educational Technology Research and Development, 53(3), 15-24.	However, much of the research has focused on devising design strategies to reduce extraneous cognitive load (for a summary see Sweller et al., 1998; Sweller, 1999).
Sweller, Merreinboer, & Paas (1998)	Clarke, T., Ayres, P., & Sweller, J. (2005). The Impact of Sequencing and Prior Knowledge on Learning Mathematics Through Spreadsheet Applications. Educational Technology Research and Development, 53(3), 15-24.	In particular, it is argued by cognitive load theorists (see Paas, Renkl, & Sweller, 2003; Sweller, 2003; Sweller et al., 1998) that information stored in long-term memory can vastly increase the capacity of working memory.
Sweller, Merreinboer, & Paas (1998)	Clarke, T., Ayres, P., & Sweller, J. (2005). The Impact of Sequencing and Prior Knowledge on Learning Mathematics Through Spreadsheet Applications. Educational Technology Research and Development, 53(3), 15-24.	Using new technologies to enhance the learning and teaching of mathematics is highly recommended by many professional teaching associations. However, when learning from computer-based instructional material, a number of cognitive load theory (CLT) principles need to be followed to ensure that learning is maximized. While much is known about how computer-based materials should be presented to avoid negative effects such as split-attention and redundancy (e.g., see Sweller, van Merriënboer, & Paas, 1998), less is known about the interactions associated with learning how to use technology while simultaneously learning mathematical concepts. How should instructional materials be structured so learners can employ technology in order to enhance understanding of mathematics? In this article we investigate how sequencing the learning of spreadsheet skills affects learning mathematics.
Sweller, Merreinboer, & Paas (1998)	De Croock, M., Paas, F., Schlanbusch, H., & Van Merrienboer, J. (2002). ADAPTIT: Tools for Training Design and Evaluation. Educational Technology Research and Development, 50(4), 47-58.	The model is fully consistent with cognitive load theory, because its instructional methods ensure that learners are continually confronted with whole tasks that yield an acceptable cognitive load (van Merriënboer, Kirschner & Kester, submitted; for a review, see Sweller, van Merriënboer, & Paas, 1998).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Sweller, Merreinboer, & Paas (1998)	Fiorella, L., Vogel-Walcutt, J., & Schatz, S. (2012). Applying the Modality Principle to Real-Time Feedback and the Acquisition of Higher-Order Cognitive Skills. Educational Technology Research and Development, 60(2), 223-238.	For instance, extraneous load is that which is devoted toward information irrelevant to learning, while germane load is necessary for learning and associated with the construction of schemas (Sweller et al. 1998).
Sweller, Merreinboer, & Paas (1998)	Fiorella, L., Vogel-Walcutt, J., & Schatz, S. (2012). Applying the Modality Principle to Real-Time Feedback and the Acquisition of Higher-Order Cognitive Skills. Educational Technology Research and Development, 60(2), 223-238.	In addition to its limited capacity, a major assumption of CLT is that working memory consists of two subcomponents that process visual and auditory information, respectively (Sweller et al. 1998).
Sweller, Merreinboer, & Paas (1998)	Fiorella, L., Vogel-Walcutt, J., & Schatz, S. (2012). Applying the Modality Principle to Real-Time Feedback and the Acquisition of Higher-Order Cognitive Skills. Educational Technology Research and Development, 60(2), 223-238.	According to cognitive load theory (CLT; Chandler and Sweller 1991), instructional design should be based on an understanding of human cognitive architecture and, in particular, its limited capacity to process information (Sweller et al. 1998).
Sweller, Merreinboer, & Paas (1998)	Fiorella, L., Vogel-Walcutt, J., & Schatz, S. (2012). Applying the Modality Principle to Real-Time Feedback and the Acquisition of Higher-Order Cognitive Skills. Educational Technology Research and Development, 60(2), 223-238.	Further, according to cognitive load theory, there are three types of cognitive load (i.e., extraneous, intrinsic, and germane), which vary in their impact on learning (Sweller et al. 1998).
Sweller, Merreinboer, & Paas (1998)	Fiorella, L., Vogel-Walcutt, J., & Schatz, S. (2012). Applying the Modality Principle to Real-Time Feedback and the Acquisition of Higher-Order Cognitive Skills. Educational Technology Research and Development, 60(2), 223-238.	Thus, according to CLT, cognitive efficiency depends largely on the extent to which instructional information is presented across both subcomponents (Mayer and Moreno 2003; Sweller et al. 1998).
Sweller, Merreinboer, & Paas (1998)	Gerjets, P., Scheiter, K., & Schuh, J. (2008). Information Comparisons in Example-Based Hypermedia Environments: Supporting Learners with Processing Prompts and an Interactive Comparison Tool. Educational Technology Research and Development, 56(1), 73-92.	Studying multiple examples can be very demanding because of the vast amount of information that has to be processed simultaneously in order to identify the commonalities and differences among the examples, thus resulting in a substantial amount of cognitive load (Sweller et al. 1998).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Sweller, Merreinboer, & Paas (1998)	Gerjets, P., Scheiter, K., & Schuh, J. (2008). Information Comparisons in Example-Based Hypermedia Environments: Supporting Learners with Processing Prompts and an Interactive Comparison Tool. Educational Technology Research and Development, 56(1), 73-92.	With regard to the acquisition of problem schemata, studying worked examples (i.e., example problems together with a step-by-step solution) seems to be superior to directly teaching abstract principles as well as to actively solving training problems—at least with regard to initial skill acquisition (cf. Atkinson et al. 2000; Sweller et al. 1998). Although many studies have focused on contrasting the exposure to worked-out examples with alternative instructional devices—such as practice problems or abstract instruction—there is also work demonstrating that students' strategies of processing worked-out examples are a critical factor with regard to learning outcomes. That is, the mere availability of instructional examples is not sufficient to guarantee the acquisition of schemata that are helpful for later problem solving. Rather, a profitable utilization of worked-out examples has to be ensured. Research over the last 15 years has revealed that there are mainly two types of processes that are responsible for successful schema construction from worked-out examples, namely, example elaborations and example comparisons.
Sweller, Merreinboer, & Paas (1998)	Gerjets, P., Scheiter, K., & Schuh, J. (2008). Information Comparisons in Example-Based Hypermedia Environments: Supporting Learners with Processing Prompts and an Interactive Comparison Tool. Educational Technology Research and Development, 56(1), 73-92.	With regard to these pivotal processes of example-based learning, using nonlinear hypermedia environments to present multiple instructional examples together with abstract expository text might support the comparison of examples within and across problem categories as well as the comparison of examples with abstract information. We hypothesize that the linking capabilities of hypermedia environments and the resulting distributed representation of information might provide navigational affordances for example comparisons and example elaborations (thereby stimulating cognitive processes that are associated with germane cognitive load). In contrast to linear information structures, each information unit can be explicitly related to a large number of other units by means of hyperlinks. This approach supports learners in engaging in numerous comparisons and elaborations. The linking capabilities of hypermedia environments and the resulting distributed information representation might thus be helpful to improve schema construction. However, one also has to consider that the same features of hypermedia environments that have the potential of increasing germane cognitive load might also impose ineffective or extraneous cognitive load on the learner. For instance, presenting worked-out examples by means of hypermedia increases control demands for learners and might result in disorientation and cognitive overload. Additionally, a distributed representation of information might cause split-attention effects, in which learners must integrate different sources of information simultaneously. Split-attention effects impose substantial extraneous load onto learners' working memory (Sweller et al. 1998). This effect has to be taken into account when designing example-based hypermedia environments

Sample Seminal Publication	Citing ETRD Article	Citation Context
Sweller, Merreinboer, & Paas (1998)	Gerjets, P., Scheiter, K., & Schuh, J. (2008). Information Comparisons in Example-Based Hypermedia Environments: Supporting Learners with Processing Prompts and an Interactive Comparison Tool. Educational Technology Research and Development, 56(1), 73-92.	According to the cognitive load theory (Sweller et al. 1998), these processes may impede learning because they require cognitive resources that may exceed the limits of working-memory capacity. Cognitive load due to the requirements of selecting and integrating information and due to the interaction with the computer (so-called extraneous cognitive load) may thus reduce the possible benefits of hypermedia-assisted learning (Gerjets et al. 2000).
Sweller, Merreinboer, & Paas (1998)	Gulikers, J., Bastiaens, T., & Kirschner, P. (2004). A Five-Dimensional Framework for Authentic Assessment. Educational Technology Research and Development, 52(3), 67-86.	If they are forced to do this, it may result in cognitive overload and, in turn, have a negative impact on learning (Sweller, Van Merriënboer, & Paas, 1998).
Sweller, Merreinboer, & Paas (1998)	Hannifin, M., Hannafin, K., & Gabbitas, B. (2009). Re-Examining Cognition During Student-Centered, Web-Based Learning. Educational Technology Research and Development, 57(6), 767-785.	Classically, cognitive psychologists characterized prior knowledge as networked schema which represents the organization of, and relationships among, each individual's existing knowledge and skill: The more extensive and connected, the richer the prior knowledge organization (schema), the more amenable to encoding new, related knowledge (see, for example, review by Sweller et al. 1998).
Sweller, Merreinboer, & Paas (1998)	Hannifin, M., Hannafin, K., & Gabbitas, B. (2009). Re-Examining Cognition During Student-Centered, Web-Based Learning. Educational Technology Research and Development, 57(6), 767-785.	Table 1 Contrasting cognitive demands of externally directed and student-centered perspectives on learning. Cogntive Load. Externally Directed. Learning and Informatoin flow is structured and metered per external criteria. Cognitive load anticipated through structured designs that manage working memory demands (Sweller et al. 1998)
Sweller, Merreinboer, & Paas (1998)	Hannifin, M., Hannafin, K., & Gabbitas, B. (2009). Re-Examining Cognition During Student-Centered, Web-Based Learning. Educational Technology Research and Development, 57(6), 767-785.	Sweller et al. (1998), for example, detailed links between instruction strategies and cognitive architecture, and provided recommendations for managing cognitive demands.
Sweller, Merreinboer, & Paas (1998)	Kay, R. & Knaack, L. (2009). Assessing Learning, Quality and Engagement in Learning Objects: The Learning Object Evaluation Scale for Students (LOES-S). Educational Technology Research and Development, 57(2), 147-168.	Cognitive load theory (Chandler and Sweller 1991; Kester et al. 2006; Van Gerven et al. 2006; Sweller 1988; Sweller et al. 1998) has been used to organize and explain the potential impact that the features of a learning object can have on performance.
Sweller, Merreinboer, & Paas (1998)	Moreno, R. & Valdez, A. (2005). Cognitive Load and Learning Effects of Having Students Organize Pictures and Words in Multimedia Environments: The Role of Student Interactivity and Feedback. Educational Technology Research and Development, 53(3), 35-45.	Lastly, because cognitive overload is very likely to occur when learning from a multiple representation interactive environment (Moreno & Durán, 2004), our study is concerned with the limited capacity assumption of CMTL, a central thesis of cognitive load theory (CLT), (Chandler & Sweller, 1991; Paas, Tuovinen, Tabbers, & Van Gerven, 2003; Sweller, van Merriënboer, & Paas, 1998).
Sweller, Merreinboer, & Paas (1998)	Morrison, G. & Anglin, G. (2005). Research on Cognitive Load Theory: Application to E-Learning. Educational Technology Research and Development, 53(3), 94-104.	It is clear that students do have trouble translating across multiple representations. The translation process is assumed to increase working memory load, as for example in the split attention effect (Sweller, van Merriënboer, & Paas, 1998).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Sweller, Merreinboer, & Paas (1998)	Morrison, G. & Anglin, G. (2005). Research on Cognitive Load Theory: Application to E-Learning. Educational Technology Research and Development, 53(3), 94-104.	Early research based on cognitive load theory attempted to identify methods of reducing extraneous cognitive load (Sweller et al., 1998).
Sweller, Merreinboer, & Paas (1998)	Nadolski, R., Kirschner, P., Van Merrienboer, J., & Hummel, H. (2001). A Model for Optimizing Step Size of Learning Tasks in Competency-based Multimedia Practicals. Educational Technology Research and Development, 49(3), 87-101.	Cognitive load theory (Sweller, 1988; Sweller & Chandler, 1994; Sweller, van Merriënboer, & Paas, 1998) can be used to guide the selection of problem formats.
Sweller, Merreinboer, & Paas (1998)	Noroozi, O., Busstra, M., Mulder, M., Biemans, H., Tobi, H., Geelen, A., Van't Veer, P., & Chizari, M. (2012). Online Discussion Compensates for Suboptimal Timing of Supportive Information Presentation in a Digitally Supported Learning Environment. Educational Technology Research and Development, 60(2), 193-221.	Different types of exercises in IDLM, as used in this study, can increase learners' motivation and their understanding and retention of knowledge (Sweller et al. 1998), as well as facilitate the acquisition and use of domain-specific knowledge (Diederen et al. 2003).
Sweller, Merreinboer, & Paas (1998)	Noroozi, O., Busstra, M., Mulder, M., Biemans, H., Tobi, H., Geelen, A., Van't Veer, P., & Chizari, M. (2012). Online Discussion Compensates for Suboptimal Timing of Supportive Information Presentation in a Digitally Supported Learning Environment. Educational Technology Research and Development, 60(2), 193-221.	Instructional designs should seek to minimize extraneous cognitive load, for example, by simplifying the learning tasks especially in the initial stage, avoiding temporal and spatial split attention (e.g. Kirschner 2002; Sweller et al. 1998), and optimally timing the presentation of information (e.g. Kester et al. 2001; Van Merrie¨nboer and Sweller 2005).
Sweller, Merreinboer, & Paas (1998)	Noroozi, O., Busstra, M., Mulder, M., Biemans, H., Tobi, H., Geelen, A., Van't Veer, P., & Chizari, M. (2012). Online Discussion Compensates for Suboptimal Timing of Supportive Information Presentation in a Digitally Supported Learning Environment. Educational Technology Research and Development, 60(2), 193-221.	The reduction of unnecessary cognitive load is one of the crucial aspects of well-designed IDLMs (e.g. Sweller et al. 1998; Van Merrie¨nboer et al. 2003; Kester et al. 2006b).
Sweller, Merreinboer, & Paas (1998)	Noroozi, O., Busstra, M., Mulder, M., Biemans, H., Tobi, H., Geelen, A., Van't Veer, P., & Chizari, M. (2012). Online Discussion Compensates for Suboptimal Timing of Supportive Information Presentation in a Digitally Supported Learning Environment. Educational Technology Research and Development, 60(2), 193-221.	Although scholars recommend reducing extraneous cognitive load (e.g. Kester et al. 2001; Sweller et al. 1998; Van Gog et al. 2005; Van Merrie¨nboer and Sweller 2005), making learning too easy and straightforward may lead to less engagement of the learner in elaborative and deep processing (e.g. Bjork and Bjork 1992, 2011).
Sweller, Merreinboer, & Paas (1998)	Noroozi, O., Busstra, M., Mulder, M., Biemans, H., Tobi, H., Geelen, A., Van't Veer, P., & Chizari, M. (2012). Online Discussion Compensates for Suboptimal Timing of Supportive Information Presentation in a Digitally Supported Learning Environment. Educational Technology Research and Development, 60(2), 193-221.	CLT concerns the limitation of working memory capacity in terms of information that can be processed at a certain time (Sweller 2010; Sweller et al. 1998).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Sweller, Merreinboer, & Paas (1998)	Noroozi, O., Busstra, M., Mulder, M., Biemans, H., Tobi, H., Geelen, A., Van't Veer, P., & Chizari, M. (2012). Online Discussion Compensates for Suboptimal Timing of Supportive Information Presentation in a Digitally Supported Learning Environment. Educational Technology Research and Development, 60(2), 193-221.	Total cognitive load comprises intrinsic, extraneous, and germane cognitive load. Intrinsic cognitive load refers to the expertise of the learner and the nature of the learning materials being dealt with; it is therefore fixed and cannot be altered (Sweller 1988; Sweller et al. 1998).
Sweller, Merreinboer, & Paas (1998)	Paas, F., Tuovinen, J., Van Merrienboer, J., & Darabi, A. (2005). A Motivational Perspective on the Relation Between Mental Effort and Performance: Optimizing Learner Involvement in Instruction. Educational Technology Research and Development, 53(3), 25-34.	CLT is concerned with the instructional control of the high cognitive load typically associated with the learning of complex cognitive tasks. The theory suggests that learning happens best under conditions that are aligned with the cognitive architecture. The theory's focus on the interaction between information structures and cognitive architecture has resulted in the development of many effective and efficient instructional methods, requiring less training time and less mental effort to attain better learning and transfer performance than conventional instructional methods produce (for an overview see Paas, Renkl et al., 2003, 2004; Sweller, van Merriënboer, & Paas, 1998).
Sweller, Merreinboer, & Paas (1998)	Pastore, R. (2010). The Effects of Diagrams and Time-Compressed Instruction on Learning and Learners' Perceptions of Cognitive Load. Educational Technology Research and Development, 58(5), 485-505.	Cognitive load is comprised of three types of load that are referred to as extraneous (affected by the design of the instruction), intrinsic (affected by high element interactivity), and germane (generated by instructional activities leading to schema development and automation) (Sweller et al. 1998; Moreno 2006; Mayer 2005).
Sweller, Merreinboer, & Paas (1998)	Pociask, F. & Morrison, G. (2008). Controlling Split Attention and Redundancy in Physical Therapy Instruction. Educational Technology Research and Development, 56(4), 379-399.	It is for this reason that cognitive load design strategies such as reducing split attention and redundancy, using a goal-free as opposed to means-end approach to problem solving, and using worked examples have been shown to be effective in areas involving more complex and novel learning tasks; where both element complexity and element interactivity are typically high and memory resources are likely to be taxed (Sweller 1994; Sweller and Chandler 1994; Sweller et al. 1998).
Sweller, Merreinboer, & Paas (1998)	Pociask, F. & Morrison, G. (2008). Controlling Split Attention and Redundancy in Physical Therapy Instruction. Educational Technology Research and Development, 56(4), 379-399.	Cognitive load theory proposes that total cognitive load or the total amount of mental load that is imposed on working memory is composed of three components: (a) intrinsic cognitive load, (b) extraneous cognitive load, and (c) germane cognitive load (Sweller et al. 1998).
Sweller, Merreinboer, & Paas (1998)	Pociask, F. & Morrison, G. (2008). Controlling Split Attention and Redundancy in Physical Therapy Instruction. Educational Technology Research and Development, 56(4), 379-399.	Extraneous cognitive load (ECL) is imposed by factors such as instructional strategies, message design, interface design, and the quality of instructional materials and learning environments. ECL is readily influenced by instructional design decisions and has been the focus of much investigation (Sweller et al. 1998).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Sweller, Merreinboer, & Paas (1998)	Pociask, F. & Morrison, G. (2008). Controlling Split Attention and Redundancy in Physical Therapy Instruction. Educational Technology Research and Development, 56(4), 379-399.	In situations involving more complex cognitive tasks such as problem solving, demands placed on working memory that are not directly related to the problem can hinder learning by exceeding available cognitive resources. This problem is particularly salient in the context of a novice learner and new information (Sweller et al. 1998). In such situations, instructional principles that avoid overburdening working memory or direct the learner's available cognitive resources are needed to design efficient and effective instruction. The following discussion provides examples of how working memory is affected by instructional difficulty, redundancy, and split attention.
Sweller, Merreinboer, & Paas (1998)	Pociask, F. & Morrison, G. (2008). Controlling Split Attention and Redundancy in Physical Therapy Instruction. Educational Technology Research and Development, 56(4), 379-399.	Intrinsic cognitive load (ICL) is imposed on the learner by the nature of the material being processed and learned (Sweller et al. 1998).
Sweller, Merreinboer, & Paas (1998)	Pociask, F. & Morrison, G. (2008). Controlling Split Attention and Redundancy in Physical Therapy Instruction. Educational Technology Research and Development, 56(4), 379-399.	The mechanisms that underlie the cognitive task of learning and the factors that determine the difficulty of instructional materials have been the focus of much research over the past 30 years (Paas et al. 2003b, 2004; Sweller 1999; Sweller et al. 1998).
Sweller, Merreinboer, & Paas (1998)	Pociask, F. & Morrison, G. (2008). Controlling Split Attention and Redundancy in Physical Therapy Instruction. Educational Technology Research and Development, 56(4), 379-399.	Germane cognitive load is the remaining working memory capacity the learner uses to form schema. If the nature of the content imposes a high intrinsic load and poor design imposes additional extraneous load on working memory, then the learner may lack the working memory capacity (i.e., germane cognitive load) to form the schema needed for understanding. Consider the following example. After reviewing a web-based unit on how to calculate the mean and standard deviation in a spreadsheet that has professional narration with animated pictures, the designer decides to scroll a text version of the narration across the lower part of the screen that is synced with the voice narration. While the intrinsic cognitive load is medium to high for this content, the extraneous cognitive load is increased due to the redundancy effect created by the narration and scrolling script. The result is a reduction in working memory capacity for germane cognitive load that can prevent the formation of an appropriate schema. Germane load is indirectly influenced by manipulating extraneous cognitive load and is directly linked to schema formation and automation (Sweller et al. 1998).
Sweller, Merreinboer, & Paas (1998)	Pociask, F. & Morrison, G. (2008). Controlling Split Attention and Redundancy in Physical Therapy Instruction. Educational Technology Research and Development, 56(4), 379-399.	Research related to the physical integration of diagrams and text and the elimination of unnecessary information in order to reduce demands on working memory has been conducted with much success in the knowledge domains of biology, computer-aided design/ computer-aided manufacturing, electrical engineering, computer programming, and mathematics (Bobis et al. 1993; Chandler and Sweller 1991, 1996; Kalyuga et al. 1998; Leung et al. 1997; Sweller et al. 1998; Tarmizi and Sweller 1988).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Sweller, Merreinboer, & Paas (1998)	Schnotz, W. & Rasch, T. (2005). Enabling, Facilitating, and Inhibiting Effects of Animations in Multimedia Learning: Why Reduction of Cognitive Load Can Have Negative Results on Learning. Educational Technology Research and Development, 53(3), 47-58.	Animations can have two basic functions based on a reduction of cognitive load. (a) If they reduce the cognitive load of tasks in order to allow cognitive processing that would otherwise be impossible, then animations have an enabling function. (b) If they reduce the cognitive load of tasks that could otherwise be solved only with high mental effort, then animations have a facilitating function (cf. Mayer, 2001; Sweller & Chandler, 1994; Sweller, van Merriënboer, & Paas, 1998).
Sweller, Merreinboer, & Paas (1998)	Schnotz, W. & Rasch, T. (2005). Enabling, Facilitating, and Inhibiting Effects of Animations in Multimedia Learning: Why Reduction of Cognitive Load Can Have Negative Results on Learning. Educational Technology Research and Development, 53(3), 47-58.	Both the enabling function and the facilitating function of animation can be considered as a reduction of cognitive load (Sweller et al., 1998).
Sweller, Merreinboer, & Paas (1998)	Schnotz, W. & Rasch, T. (2005). Enabling, Facilitating, and Inhibiting Effects of Animations in Multimedia Learning: Why Reduction of Cognitive Load Can Have Negative Results on Learning. Educational Technology Research and Development, 53(3), 47-58.	From the perspective of cognitive load theory, animation can unnecessarily reduce germane load associated with deeper meaningful cognitive processing (Sweller, 1999; Sweller et al., 1998; van Merriënboer, 1997).
Sweller, Merreinboer, & Paas (1998)	Van Gog, T., Ericsson, K., Rikers, R., & Paas, F. (2005). Instructional Design for Advanced Learners: Establishing Connections Between the Theoretical Frameworks of Cognitive Load and Deliberate Practice. Educational Technology Research and Development, 53(3), 73-81.	CLT is concerned with instructional techniques for managing working memory load in order to facilitate the changes in long-term memory associated with schema construction and automation. These techniques aim at minimizing extraneous, ineffective cognitive load (i.e., not requiring complex reasoning processes with many interacting unknown chunks of information), and increasing germane, effective cognitive load that facilitates domain-specific knowledge acquisition. CLT research on instructional formats that take these principles into account has identified the following effects: the “goal-free effect,” the “worked example effect,” the “split-attention effect,” the “redundancy effect,” the “modality effect,” the “completion effect,” the “variability effect,” and the “imagination effect” (see Sweller, 2004; Sweller, van Merriënboer, & Paas, 1998).
Sweller, Merreinboer, & Paas (1998)	Van Gog, T., Sluijsmans, D., Brinke, D., & Prins, F. (2010). Formative Assessment in an Online Learning Environment to Support Flexible On-the-job Learning in Complex Professional Domains. Educational Technology Research and Development, 58(3), 311-324.	Because the application of non-recurrent skills varies from situation to situation, these can, in contrast to recurrent skills (e.g., typing) not be automated. Since conscious processing requires more cognitive capacity than automated processing, learning in complex domains with a large number of non-recurrent skills imposes a high cognitive load on the learner (Sweller 1988; Sweller et al. 1998; Van Merrie¨nboer and Sweller 2005).
Sweller, Merreinboer, & Paas (1998)	Van Merriemboer, J., Clark, R., & De Croock, M. (2002). Blueprints for Complex Learning: The 4C/ID-Model. Educational Technology Research and Development, 50(2), 39-61.	Task classes. It is clearly impossible to provide highly complex learning tasks right from the start of the training program because this would yield excessive cognitive overload for the learners, which impairs learning and performance (Sweller, van Merriënboer, & Paas, 1998).

Sample Seminal Publication	Citing ETRD Article	Citation Context
Sweller, Merreinboer, & Paas (1998)	Van Merrienboer, J. & Ayres, P. (2005). Research on Cognitive Load Theory and Its Design Implications for E-Learning. Educational Technology Research and Development, 53(3), 5-13.	Traditional effects studied by CLT and why they reduce extraneous cognitive load (reported by Sweller, van Merriënboer, & Paas, 1998).
Sweller, Merreinboer, & Paas (1998)	Wallen, E., Plass, J., & Brunken, R. (2005). The Function of Annotations in the Comprehension of Scientific Texts: Cognitive Load Effects and the Impact of Verbal Ability. Educational Technology Research and Development, 53(3), 59-71.	Recent research on multimedia learning has shown that in order to assure the instructional effectiveness of an intervention, cognitive load implications of the design of the materials have to be taken into consideration. Cognitive load theory (Brünken, Plass, & Leutner, 2003; Paas, Renkl, & Sweller, 2003; Sweller, 1999; Sweller, van Merriënboer, & Paas, 1998) describes different sources of working memory load, related to the complexity of the material (intrinsic load), the instructional design (extraneous load), and the amount of mental effort learners invest in learning the materials (germane load).
Sweller, Merreinboer, & Paas (1998)	York, C. & Ertmer, P. (2011). Towards an Understanding of Instructional Design Heuristics: An Exploratory Delphi Study. Educational Technology Research and Development, 59(6), 841-863.	Based on principles similar to those espoused by cognitive load theory (which suggests that working memory has a finite amount of processing capacity; Sweller et al. 1998), heuristics may offer one means for reducing the cognitive load experienced while solving difficult or complex problems (Lewis 2006).
Sweller, Merreinboer, & Paas (1998)	Lohr, L. (2006). Book Reviews. Educational Technology Research and Development, 54(4), 417-420.	Various authentic examples and practice throughout the book help learners connect conceptual theory to their own real-life applications. Each chapter provides examples to facilitate the construction of new knowledge that can reduce learners' cognitive load (Sweller & Chandler, 1994; Sweller, Merrienboer, & Paas, 1998; Ward & Sweller, 1990).
Sweller, Merreinboer, & Paas (1998)	Stoof, A., Martens, R., & Van Merrienboer, J. (2007). Web-Based Support for Constructing Competence Maps: Design and Formative Evaluation. Educational Technology Research and Development, 55(4), 347-368.	A phenomenarium should provide worked examples that can be used as analogies to perform the task (e.g., Gick & Holyoak, 1980; Sweller, van Merrie¨nboer, & Paas, 1998).
Sweller, Merreinboer, & Paas (1998)	Stoof, A., Martens, R., & Van Merrienboer, J. (2007). Web-Based Support for Constructing Competence Maps: Design and Formative Evaluation. Educational Technology Research and Development, 55(4), 347-368.	Finally, phenomenaria are (case) examples, which can be based on real-life projects in which competence maps are developed. Guidelines for designing phenomenaria can be found in the literature on worked examples (e.g., Paas & van Merrie¨nboer, 1994; Sweller, van Merrie¨nboer, & Paas, 1998; Ward & Sweller, 1990).

Appendix K

Knowledge Claims in Seminal Publications

Brown, Collins & Duquid (1989)

Level 1: Abstract theoretical claims	Situated cognition emphasizes that knowledge is situated in activity, context and culture and changes over time. It may be supported through a cognitive apprenticeship.	
Level 2: General claims of argument or findings	Conceptual knowledge is developed over time through authentic (real-life) activities of the culture. Learning is then the process in which the activity and culture work independently.	Cognitive apprenticeship, the "context dependent, situated and enculturating nature of learning" (p. 39), supports cognitive skills.
Level 3: Detailed claims of argument or finding	Knowledge and tools (including conceptual tools) share the following related to activity: • Activity (use) is a path to understanding • Activity (use) changes how the user perceives the world • Activity (use) changes the user's beliefs of the culture where used Learning is a process of enculturation where the learner: • Is introduced to and uses domain (context) specific tools • Solves problems in context	Cognitive apprenticeship emphasizes: • Value of domain (context) specific activity • Collaboration and social interaction • Modeling, coaching and fading to support the acquisition and development of cognitive skills Features of cognitive apprenticeship in a group setting include: • Collective problem solving • Use of multiple roles • Confrontation of ineffective strategies and misconceptions • Development of collaborative work skills Four instructional strategies that are characteristic of cognitive apprenticeship: • Begin with a connection to prior knowledge as an anchor (legitimizes implicit knowledge, scaffolds to unfamiliar) • Point to different decompositions (heuristics are assessed and not absolute) • Allow students to generate their own paths to solutions • Create a shared vocabulary as a means to discuss, reflect, evaluate and validate processe

Note: Adapted from Golden-Biddle, Locke and Reay (2006), p. 241

Miller (1956)

Level 1: Abstract theoretical claims	Exploring the capacity limitations of absolute judgment and immediate memory suggest the "significance of number seven," (p. 90) plus or minus two, though the underlying mechanisms are not the same.		
Level 2: General claims of argument or findings	Theory of information concepts allow researchers to create experiments where metrics are not typically applied and compare results across experiments.	The spans of unidimensional and multi-dimensional absolute judgement are limited but may be extended.	Immediate memory capacity is limited but may be extended through recoding.
Level 3: Detailed claims of argument or finding	Theory of information concepts include: • Communication system inputs and outputs which may be described by variance, covariance and correlation • Channel capacity, the information an observer can provide about the stimulus based on absolute judgment, which is limited and confusion results when the capacity is reached • Variance, the amount of information, where the amount needed to make a decision about two equally likely alternatives (one bit) equals 2 to the n bits. • Covariance or correlation which equates to the amount of information transmitted from inputs to outputs	The span of absolute judgement is limited by the amount of information we are able to receive, process and recall The span of unidimensional absolute judgement may be extended by: • Making relative rather than absolute judgements • Increasing the number of dimensions along which stimuli can differ • Arranging tasks so several absolute judgements are in a row (introduces memory to support discrimination) The span of unidimensional absolute judgement is approximately seven (observers can distinguish among approximately seven categories). The span of multi-dimensional absolute judgement increases at a decreasing rate as the number of variables added to a display increases (a little information about many things is better than a lot of information about fewer things	The span of immediate memory is limited by the number of items (approximately seven items/chunks in length) but is not dependent on the number of information bits within each chunk. Recoding, the process of organizing or grouping the sequence of input into chunks or units (such as rephrasing to recall the verbalization) to create fewer chunks with more bits per chunk extends the span of immediate memory capacity.

Note: Adapted from Golden-Biddle, Locke and Reay (2006), p. 241

Palincsar & Brown (1984)

Level 1: Abstract theoretical claims	Reciprocal teaching intervention supports students as they learn to apply reading comprehension-fostering and comprehension-monitoring strategies.
Level 2: General claims of argument or findings	In reciprocal teaching, students experience the activities with the teacher (expert) present and gradually perform the activities by themselves. The teacher uses scaffolds to enable students to perform on their own.
Level 3: Detailed claims of argument or finding	Four reading comprehension-fostering and comprehension-monitoring activities support reciprocal teaching: summarizing, questioning, predicting and clarifying. These strategies improve comprehension and allow students to check their understanding. Reciprocal teaching involves ongoing trial and error by the student and ongoing evaluation and modification in the teacher's "theory of the student's competence, a theory that must be responsive to the level of participation of which the student is currently capable" (p. 169) Reciprocal teaching was successful in fostering reading comprehension because of the following: • Modeling comprehension-fostering and comprehension-monitoring activities are difficult to identify by the teacher when executed. Reciprocal teaching provides a "natural forum" (p. 168) for teachers to overtly engage in activities so they may serve as a model for what they do when trying to understand and recall text. • Students have an opportunity to overtly present their competence. Reciprocal teaching forces students to respond which provides the teacher the opportunity to gauge competence and offer feedback.

Note: Adapted from Golden-Biddle, Locke and Reay (2006), p. 241

Salomon, Perkins & Globerson (1991)

Level 1: Abstract theoretical claims	Technology (cognitive tools, technology of the mind) can support cognitive processes and extend "intellectual performance" (p. 2)		
Level 2: General claims of argument or findings	Effects with technology can extend performance if students partner with technologies that complete a significant portion of the cognitive processing on behalf of the student.	Effects of technology occurs when a person partners with technology that extends cognitive capacity after being separated from the technology (in consequence of the technology)	Three broader contexts impact the use and impact of technology put into use to support cognition: normative, theoretical and practical.
Level 3: Detailed claims of argument or finding	The effects with technology depend on: • The students "mindful engagement" (p. 4) (the how) in the partnership • The interdependent division of labor that develops over time Two methods for evaluating the performance with technology: • Systemic: examines the whole system (problem: don't see student's unique contribution) • Analytic: examines the mental processes that the student contributes (favors tools that support higher order mental processes (STELLA))	Assumptions of cognitive residue: • higher order skills can be transferred • skills developed in school are not context bound "Computer tools can leave a cognitive residue" (p. 6) that can: • Support the person when working on their own (ability) • Support higher level activities when using intellectual tools	Normative – technology may deskill what one seeks to maintain Theoretical – considers technological, social and psychological variables that may impact school culture if computers become central in education Practical – relates to the combined impact of correlated variables such as activity, technology, goal, context, teacher's role and culture

Note: Adapted from Golden-Biddle, Locke and Reay (2006), p. 241

Sweller, Merrienboer & Paas (1998)

Level 1: Abstract theoretical claims	Cognitive load theory suggests that learning happens best when guidelines for designing instruction to encourage learner activities that support cognitive architecture and improve effectiveness are applied.		
Level 2: General claims of argument or findings	Learning is a consequence of information that is first processed in working memory and then stored in long-term memory through schema construction, it happens best when instructional materials align with cognitive architecture.	According to cognitive load theory, learning is more effective if cognitive load is reduced (overload prevented) by reducing required working memory resources reducing intrinsic and extrinsic load thereby increasing germaine cognitive load.	Cognitive load theory supports instructional design strategies that reduce extraneous cognitive load and can improve performance.
Level 3: Detailed claims of argument or finding	Working memory and long-term memory work together support learning through the following: • Working memory, which processes instructional material, has a limited capacity that can be extended by using both independent auditory and visual channels. • Elements handled in working memory may be transferred to long-term memory in the form of schemas • Schema construction and automation have the dual function of storing information in long-term memory and reducing the load in [limited] working memory" (p. 289) where they are originally constructed	Working memory load is impacted by intrinsic cognitive load (intrinsic nature of the instructional material) and extraneous cognitive load (presentation of material and student activities). Germaine cognitive load, created through schema construction, contributes to learning rather than interfering. When intrinsic and extraneous cognitive load leave working memory resources, learners may apply them to schema construction which increases germane cognitive load.	Cognitive load theory effects include: • Goal-Free: problem with non-specific goals (reduces extraneous load by connecting problem to goal state and reduces their differences) • Worked Example: problems that must be studied carefully (reduces extraneous load caused by weaker problem solving methods and supports schema construction) • Completion Problem: provide partial solutions that the learner completes (reduces extraneous load by reducing the problem space) • Split Attention: Integrate sources of attention rather than providing multiple sources (reduces extraneous load by eliminating need to integrate information across sources) • Modality: Use visual information rather than explanatory text, such as a diagram or the same paired with spoken explanation (reduces extraneous load by using both visual and auditory working memory processors) • Redundancy: Replaces multiple sources of information that were self-contained, and not understandable on their own, with a single source. This is not suitable for expert learners. (reduces extraneous load caused by redundancy) • Variability: Provide variable training (Increases germane load which encourages schema development by increasing the number of similar and relevant features.)

Note: Adapted from Golden-Biddle, Locke and Reay (2006), p. 241

Appendix L

Typology of Theory Symbol Use as Applied to a Sample of Seminal Publications Cited in ETRD

Type	Number	Variable	Code and Total Average (Or Other Key Finding) for Sample
Manifest	1	Theory symbol age	(specify) 13.9
	2	Author and Writer relation	1. Reciprocal (self-citation) ....0.0% 2. Parallel (co-writer is also an author) ....4.4% 3. Unrelated...95.6%
	3	Citing article topic	(specify)24.1% (applicable to cognition, highest ranking category)
	4	Multiplicity	(specify) .12 (citations per page to seminal publication)
	5	Location of citation	1. Abstract ....0% 2. Introduction..17.8% 3. Literature review/Framework ....70.6% 4. Methodology ....1.6% 5. Results/Discussion/Future Research..................8.4% 6. Conclusion ....1.6% 7. Other (specify)...0%
	6	Citation clustering	1. None (no additional citations)..........................42.2% 2. Small cluster (1 to 2 additional citations)..........38.1% 3. Large cluster (3 or more additional citations)...19.7%
	7	Citation integration	1. Explicit (name in sentence) ....12.2% 2. Implicit (name in table, parenthesis or footnote) 87.8%
	8	Citation style	1. Summary ....97.5% 2. Short quote (contained in a single sentence) .....2.2% 3. Long quote (two or more sentences)...................3%
Latent	9	Theory symbol materialization	1. Comprehensive...6% 2. Selective .....68.4% (Level 1 – 13.8%, Level 2 – 26.6%, Level 3 – 28.1%) 3. Peripheral ....8.8% 4. Typification 22.2%