Chapter 8
Critical Thinking in the Field of Educational Technology: Approaches, Projects, and Challenges

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Critical thinking is commonly acknowledged as an important endeavor across scholarly fields and professions. It is relevant to a wide expanse of activities and is conceptualized in a number of ways (see, for example, Ennis, 1962; McPeck, 1981). In education it is especially valued as a target skill for learners and often referred to as necessary in a new and changing world (Combs, Cennamo, & Newbill, 2009; Paul & Binker, 1990).

For many scholars and educators, critical thinking refers to thinking directed at purposefully evaluating or making judgments. Some scholars have asserted that this is achieved through the rigorous application of methods (Glaser, 1941), while others have maintained that critical thinking includes a range of analytic thought activity (Ennis, 1987; Paul, 1987). However, traditional definitions of critical thinking can fail to address important aspects of one's practice and beliefs, merely perpetuating current beliefs and ideas (Johnson, 1992; Thayer-Bacon, 2000). Some scholars have argued for critical thinking as a means of developing new perspectives, understandings, and practices. This kind of critical thinking must undertake to uncover assumptions—assumptions held by an individual engaged in practice or by a community of practitioners or assumptions embedded in a body of commonly held theories, methods, and practices. Critical thinking not only entails the explication of assumptions, but also the identification of implications of those assumptions. In this sense, critical thinking becomes a means for improving theory and practice. Additionally, engaging in such critical thinking may include, but extend beyond mere analytic thinking. After all, analytic thinking must rely on the thinking one already possesses, and as

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such, risks merely reifying existing ideas and beliefs. Other activities can be undertaken to contribute to uncovering assumptions and discovering new perspectives.

In educational technology critical thinking has primarily received attention as a skill to be advanced in learners through a variety of techniques such as technology-mediated activities (Butchart et al., 2009), facilitated peer interactions in a learning environment (Anderson, Howe, Soden, Halliday, & Low, 2001; Chiu, 2009), and methods for scaffolding the development of critical thinking (Belland, Glazewski, & Richardson, 2008; Kim, 2015). This reflects the view that critical thinking is a useful skill that should be developed and supported in others.

However, there has been far less discussion of critical thinking as a form of professional activity within the field of educational technology. To be sure, critical thinking has played an important role in advances and development of the field, including exploring new perspectives and paradigms (Hannafin & Land, 1997; Jonassen, 1991; Spector, 2001), examining practices (McDonald & Gibbons, 2009), exploring methodologies (Amiel & Reeves, 2008), and developing tools aligned with theoretical views (Duffy & Cunningham, 1996). By focusing on critical thinking as professional activity in this chapter, we hope to highlight opportunities for growth for individuals and as a field in general. In what follows, then, we discuss critical thinking in educational technology in two steps: first, we describe two critical thinking activities that we see as particularly needed in the field; second, we identify areas of educational technology that seem to require the most penetrating critical analyses.

Examining Assumptions and Implications

Of the many forms of critical thinking discussed across scholarly literatures, we wish to focus on two that we consider to be particularly relevant to the field of educational technology. We see these as relevant because of their emphasis on examining the meaning of core disciplinary concepts and practices that have received as yet insufficient critical scrutiny. The first critical thinking activity is concerned primarily with underlying assumptions, particularly those that provide a conceptual foundation for work in the field. The second critical thinking activity, which we will present after our discussion of assumptions, is concerned primarily with reexamining the fundamental and in many cases longstanding questions and practices of the field. More specifically, this critical thinking approach is based on Finn's assessment criteria for professionalism and offers a vehicle for assessing the state of educational technology as a field.

In contrast to critical thinking approaches that emphasize rule following—that is, approaches which emphasize the degree to which various systems of logic, methods, and procedures have been correctly followed (for a review, see Yanchar, Slife, & Warne, 2009)—assumption-based approaches seek to explore what lies beneath such prescriptions, examining the values or precepts they seem to be based on. While rule-following approaches are certainly valuable, in that they place rigorous checks on issues such as invalid logic, erroneous uses of method, and so on, they are not capable of testing their own conceptual undergirdings (Yanchar et al., 2009). For example, thinking critically about traditional experimental research methods usually entails the inspection of issues such as internal validity, sample size, and statistical analysis. Such an approach does not, on the other hand, provide resources for questioning the notion of causation that internal validity is based on (though it has been questioned in other ways) or the notion of generalizability that gives rise to concerns about proper sample size. The examinations we call for are deeper, in a sense, and demand different kinds of critical thinking activities, namely, those that are concerned with basic assumptions that guide work in the field.

This critical thinking activity has been discussed in related fields such as various subareas of psychology, though often by theoretically inclined scholars who seek to foster a critical dialogue regarding the meaning of disciplinary practices (Burgess-Limerick, Abernathy, & Limerick, 1994; Slife, Reber, & Richardson, 2005). It is hoped, from this perspective, that critical thinking and dialogue may expose assumptive frameworks that drive scholarship in a given domain, allowing those frameworks to be scrutinized regarding their implications—that is, regarding where they take practitioners and scholars who explicitly or implicitly accept them. While such analysis is often conducted by scholars associated with critical theory as a unique intellectual movement (Fox, Prilleltensky, & Austin, 2009; Leonardo, 2004; Mezirow, 2009), careful examinations of assumptions and implications are also conducted by adherents of other theoretical positions including various forms of positivism (Smith, 2002), postmodernism (Gergen, 1994), hermeneutics (Yanchar et al., 2009), and feminism (Thayer-Bacon, 2000).

Scholars who engage in this sort of critical analysis pay close attention to several categories assumptions, most commonly, those concerning the nature of human action, motivation, knowledge, development, embodiment, and ethics (e.g., Fox et al., 2009; Slife et al., 2005). Examinations such as these have proven insightful and fostered alternatives in the scholarly literature. As an example, one might consider the rise of situated learning theories (e.g., Lave & Wenger, 1991), which were introduced as significant conceptual alternatives to cognitivist views of learning. As a second example, consider Jonassen's (1991) analysis of objectivist and constructivist views of learning, which offered a useful comparison and contrast of these rival philosophical positions. More general categories of assumptions are often relevant as well, such as those pertaining to the nature of time (Slife, 1993), causation (Rychlak, 1994), technology (Davis, 2006), and sociocultural structure (Giddens, 1979). Again, critical examinations of these and related issues have yielded a number of insights and suggested alternative conceptualizations. Because this activity is designed to explicate what is often taken for granted and lay it bare for examination, has been described as one of the most fundamental or important forms of critical analysis (Brookfield, 1987; Keeley, 1992; Slife & Williams, 1995; Yanchar et al., 2009).

In the field of educational technology, the most traditionally relevant categories of assumptions would seem to have to do with knowledge, mind, human-world interactions, and technology. These are clearly at the base of prominent views of learning such as behaviorism, cognitivism, and constructivism, each of which stakes out a position on the nature of human involvement in the world with a special focus on how humans "know," as well as technologies designed to facilitate the process of knowledge or skill acquisition. Other assumptions are be relevant as well—for example those pertaining to the nature of human identity, communal interaction, and tool use—especially with regard to sociocultural and situated approaches to learning (Daniel, 2008).

One example of such critical analysis in the field was offered by McDonald, Yanchar, and Osguthorpe (2005), who explored parallels between early programmed instruction efforts and contemporary online learning. Through their examination, these authors identified several underlying assumptions of programmed instruction that, according to their analysis, led to the historical demise of this technological movement. In particular, these authors identified assumptions traditionally associated with behaviorism such as social efficiency, ontological determinism, and technological determinism (Delprato & Midgley, 1992; Smith, 1992). Importantly, through this critical examination, these authors identified similar assumptions among many examples of contemporary online instruction, suggesting that they tend to suffer from the same deficiencies as programmed instruction. As a result of this analysis, the authors offered a number of suggestions on how to avoid these assumptions and their negative affects, including a set of critical questions that designers can ask themselves in order to examine their own assumptions and possibly avoid those that appear to be problematic.

It is important to add, however, that this form of critical thinking involves more than the identification of underlying assumptions and an examination of their implications; it is facilitated by comparing the identified assumptions and implications with others in other to provide an illuminating contrast. Often the meaning and consequences of a given assumption's implications becomes clearest when compared against others with different implications. For example, assumptions found in cognitive information-processing models (e.g., acquisition, commoditization, mechanism) are revealed when contrasted with those of constructivist (Jonassen, 1991) or situated learning (Bredo, 1994) approaches. As Sfard (1998) noted, metaphors such as *knowledge acquisition* often do not seem like metaphors at all until compared with others. Indeed, such comparison and contrast is a vital way to clarify ideas and explore where they take those who follow them.

Finn's Criteria for Professionalism

In the early 1950s, James D. Finn, then Chairman of the Department of Audio-Visual Instruction (DAVI) of the National Educational Association (NEA), noted the increasing specialization of education-related occupations, including "administration, psychologists, curriculum consultants, counselors, and other educational specialists" (Finn, 1953, p. 6). He noted also the emergence of an occupational group "whose main responsibility lies in the preparation, distribution, and use of audio-visual materials" (p. 6). In his article, titled "Professionalizing the Audio-Visual Field," Finn saw this latter group as "unique," in that their concerns cut across all branches of communication and technology, "bringing new disciplines to bear upon the problems of education" (p. 6).

Finn called for increased professionalism in this emerging specialty. His 1953 article was the first of a series of papers written over nearly a decade, as the A-V field transitioned into the professional community today called Educational Technology (Finn, 1953, 1957a, 1957b, 1960a, 1960b, 1962).

At the beginning of this period, the computer was being explored by scientists and psychologists (from outside the A-V field) for its educational potential (Atkinson & Wilson, 1969). By 1962, Finn was describing a new armada of technological innovations that were being ignored by philosophers of education, he felt, because they found them "trivial" and even "dangerous" (p. 30).

From the beginning, Finn urged the A-V field to develop its professionalism by critically examining itself in six areas. Of the six, three are of importance to this discussion of critical thinking: (a) using "an intellectual technique" (p. 2), (b) applying the technique to solve humankind's problems, and (c) possessing "an organized body of intellectual theory constantly expanded by research" (p. 2). These, said Finn, were critical tools of a true profession. For comparison purposes, Finn held up examples of professional fields such as medicine, law, accounting, and engineering.

In his 1953 paper, Finn assessed the state of the art as he saw it, addressing the question: How close is A-V [today educational technology] to being legitimized as a profession? To enable critical thinking regarding the status of educational technology, we suggest questions that members of the educational technology community can use today to assess for themselves the state of the art in educational technology with respect to these three of Finn's criteria, from a 60-year vantage point.

To frame our questions, we will appeal to categories of design knowledge suggested by Vincenti (1990) in his book *What Engineers Know and How They Know It*. Vincenti's categories represent types of knowledge designers in any design field typically use. These categories define focal points for further conversations on Finn's question: "How well does educational technology meet the criteria for being a professional field?" In the quoted text below, in places where Vincenti has used the term "device," we have substituted the term "artifact," which we believe preserves Vincenti's meaning without conveying the notion that educational technologists design only devices. We likewise substitute the term "designer" in place of Vincenti's use of the term "engineer."

Finn's Intellectual Technique Criterion

The intellectual technique of a field consists its ability to intellectualize its content in ways that lead to the logical, consistent application of principles, as well as connecting key abstractions with elements of practical applications. In this respect, Finn cited activities such as "think[ing] reflectively," "critical evaluation," and "visualization of abstract concepts" (p. 8). Today, we might refer to this as the ability of a field to engage in critical thinking about itself. Critical thinking is associated with a cloud of intellectual processes by which ideas and processes are formulated, expressed, examined, questioned, tested, proven, discussed, and used within a field.

In our opinion, five of Vincenti's knowledge categories fit under Finn's intellectual technique umbrella. Each category suggests questions about the state of our professional knowledge base.

Fundamental Design Concepts

Vincenti groups two types of professional knowledge under the heading of fundamental design concepts: Operational Principles, and Normal Configurations. Vincenti describes them in this way: "Designers setting out in any normal design bring with them fundamental concepts about the device [artifact] in question" (p. 208).

Operational Principles

Operational principle knowledge pertains to "how the [artifact] works" (p. 208). By this, Vincenti means the manner in which an artifact channels energies and information to the point where are applied to accomplish the work.

A visible physical structure, like a building, represents a balance of numerous opposing forces working invisibly to create a stable edifice. Changes in applied forces shift the inner balance of the structure, either strengthening it or weakening it. Likewise, invisible forces that are conveyed through visible means impact the state of mind of a learner. Changes in the balance of forces perceived by a learner shift the learner's state of mind in the direction of either greater understanding or greater processing load and possible confusion. According to Vincenti, "[designers] dealing with any [artifact] must… know its operational principle to carry out normal design" (p. 209). Questions educational technologists should consider include:

- To what extent does educational technology literature deal with the hidden forces at work within the visible means of their technology?
- Do educational technologists have the research tools to ferret out these invisible forces and how visible means apply them?

Normal Configurations

Vincenti defines normal configurations as "the general shape and arrangement that are commonly agreed to best embody the operational principle" (p. 209). Automotive designers use the concept of "platform" to describe normal configurations. A platform is a standard basic design, which is then featured differently to create visibly distinct models, perhaps by installing a more powerful engine or a different transmission. To the public, platforms fall into categories like "SUV," "van," or "pickup." In this way, the designer's categories of platform result in vehicle categories users want to buy. Questions educational technologists should consider include:

- Are educational technologists aware of the normal configuration concept?
- Do designers have shared normal configurations of educational artifact?
- Do designers use the platform concept to create artifact variations that consumers desire to use?
- Are shared normal configurations useful in an increasingly competitive educational marketplace?

Criteria and Specifications

Criteria and specifications bridge abstract ideas with real world designs. Criteria "translate the general, qualitative goals for the [artifact] into specific, quantitative goals couched in concrete technical terms" (Vincenti, p. 211). For example, Vincenti explains that the concept of a bridge to carry traffic over a river has to be translated "into specific span and loading requirements" that have "numerical values or limits" (p. 211).

Educational technologists are benefitting from the new concept of learning analytics that suggests that techniques for numerical analysis may, over time, be perfected for the detection and prediction of learner needs, and interaction patterns that match them. This may in turn lead to increased specificity in the description of designs. Questions educational technologists should consider include:

- Do we presently have adequate principles for specifying goals and criteria for outcomes for which designs are being created?
- Do we have methods (and terminology) for detecting (and characterizing) learner needs at any given point in time?
- Do we have languages for describing the characteristics of design elements in terms of the positive learning forces they generate?
- Do we have languages for describing how detected needs can be matched with relevant recommendations for learning experiences?

Design Instrumentalities

Design instrumentalities include "knowing how," "procedural knowledge," "ways of thinking," and "judgmental skills," according to Vincenti (p. 219). "They give [designers] the power, not only to effect designs where the form of the solution is clear at the outset, but also to seek solutions where some element of novelty is required" (p. 219). Design instrumentalities comprise what a design profession knows about how to design solutions to its problems.

Educational technologists have relied upon systematic design approaches for over 50 years. Recently, new approaches to design have joined them, along with new ways of describing designer thinking and design reasoning (Boling & Gray, 2014; Boling & Smith, 2012; Dorst, 2015; Gibbons, 2014; Gibbons & Yanchar, 2010; Lawson & Dorst, 2009; Rowland, 1993; Smith & Boling, 2009). Likewise, new ways of describing the identity of the designer, design ethics, and the designer's role have emerged (Campbell & Schwier, 2009; Hokanson, Clinton, & Tracey, 2015; Hokanson & Gibbons, 2014; Parrish, 2007, 2008). Since designing implies an understanding of what is being designed, literature trying to describe the nature of learning artifacts is relevant as well (Gibbons, 2003; Krippendorff, 2006).

More mature design professions still have lively internal debates on all of these issues, which often are sources of philosophical and technical innovation within those fields. Educational technologists can profit from looking at design as it is practiced in other fields, while asking:

- Does educational technology have a clear conception of the nature of designing as it applies to educational artifacts and experiences?
- Does educational technology have a clear vocabulary for describing the kinds of artifacts it designs?
- Has educational technology done due diligence to the questions of design competence, design process, design thinking, and design judgment?
- Are there distinguishable levels of design practice that are relevant to the certification of practitioners?
- Are training requirements for different levels of practice well defined?
- What constitute appropriate philosophical and theoretical bases for descriptions of design instrumentalities?

Practical Considerations

Practical considerations, according to Vincenti, represent uncodified, imprecise knowledge, often derived from practical experience rather than research, that is nonetheless a part of expert practice. Practical considerations "do not lend themselves to theorizing, tabulation, or programming into a computer." This kind of knowledge is normally "hard to find written down," and "more or less unconsciously" carried around in designers' minds (p. 217).

A great deal of the knowledge of educational technologists is of this kind. This is typical of a design field in its early development, especially one in which the design problems are what Jonassen called "wicked" (Jonassen, 2004). Wicked problems are not unique to instructional design (see, for example, Rittel & Webber, 1973). It is the non-verbalized, somewhat unconscious nature of the knowledge of a field that makes learning by apprenticeship attractive, and in some cases even necessary (Lave & Wenger, 1991). Fields such as medicine, law, accounting, and engineering today rely on intensive training programs followed by varying degrees of apprenticing. This has not always been the case, and these professions originally all relied on extended apprenticeship experience.

Since they have a particularly invested interest in practical considerations, and since Finn gave as one of his criteria for professional status "a period of long training necessary before entering into the profession" (Finn, 1953, p. 7), educational technologists should be interested in questions like:

- How can a design field aspiring to be professional decrease its reliance on practical considerations and codify its knowledge to a greater extent?
- What kinds of knowledge are required for both theoretical and practical practice in a profession?
- How can programmatic and cooperative research serve to focus and accelerate research aimed at codifying the professional knowledge base in educational technology?

Finn's Criterion of Applying Intellectual Technique to Solving Problems

The second area of professionalization named by Finn (1953) pertaining to educational technology was an application of intellectual technique to solving humankind's problems. The question of whether educational technology is solving problems can be addressed from different points of view. Indisputably, educational technology is being applied today for educational purposes to an unprecedented degree in virtually every learning venue. The question is whether this is due to the success of "technology" in noticeably improving educational effects, or simply to the everywhere-ness of computer technologies, which are rapidly swallowing all other forms of A-V. Those who grew up in educational technology before the computer remember that the early struggle to achieve adoptions of new technologies was ideological as well as economic. Today, that struggle is much less a matter of convincing stubborn minds and more one of obtaining funds.

Not everyone is convinced that educational technologies like the computer have succeeded in improving learning. Cuban (2001), summarizing a study of the K-12 application of computer technology in the Silicon Valley area, reports: "no advances (measured by higher education achievement of urban, suburban, or rural students) over the last decade can be confidently attributed to broader access to computers" (n.p.). Further, he reports, "the link between test score improvements and computer availability and use is even more contested" (n.p.). He also reports finding no effect on either student or teacher productivity. Similarly, a recent OECD report "Students, Computers, and Learning: Making the Connection" (OECD, 2015) concludes that high expectations of learning improvement through implementation of computers in international classrooms were not supported.

Positive expectations of large-scale computer implementations are sometimes economically motivated. Sometimes the economics can be traced directly to sponsorship by a computer or publishing company. Sometimes political ownership by a government or a school district is a motive. In some cases, subtle connections are traceable, as in a report by the New York Times which showed that the benefit to one school district, which knew that its learning scores had stagnated in comparison with the state, came from "using its computer-centric classes as a way to attract children from around the region, shoring up enrollment [even] as its student population shrinks" (Richtel, 2015, n.p.).

It is largely agreed that media comparison studies have little value, so if technologists wish to demonstrate that their artifacts and interventions have an impact on the problems of humankind, they must make an argument that they employ improved technique rather than technology. This is perhaps a conversation that should be taken up among educational technologists themselves, many of whom are more attracted to the charismatic "gadget" than the actual result demonstrated by research and linked to theory. Reeves (2011) noted that many studies "confound educational delivery modes with pedagogical methods" (n.p.). He notes Bransford's recommendation that:

To heighten the relevance of research that would have demonstrable impact of the kind and level heretofore missing in education, a refocusing of research and educational designs on the fundamental concerns of the practitioner is necessary (Reeves, 2011, n.p.).

As educational technologists discuss among themselves ways they can make their research, theory, and practice more readily applicable to solving humankind's problems, they should also consider other barriers to acceptance. The first is willingness to dialogue with other design fields and adopters of technology in a collegial manner. Selwyn (2014) notes that:

> Unlike most other fields of academic study, educational technology appears particularly resistant to viewpoints that contradict its core beliefs and values—not the least the orthodoxy that technology is a potential force for positive change" (p. 12).

A second issue, also noted by Selwyn, is a kind of arrogance that can be traced to the earliest days of the educational technology field:

> Educational technology has… become a curiously closed field of study—populated by people who consider themselves to be in the somehow more informed position of properly understanding the educational potential of digital technology. This can sometimes lead writers and researchers to adopt an intellectual stance that is evangelical—if not righteousness—in its advocacy of this 'truth' (p. 12).

Educational technologists in one sense *need* to feel defensive about having a profession that dissolves so easily into other professions. Every rocket scientist can jump into instructional design, but educational technologists do not even think about designing rockets. At the same time, if educational technologists had intellectual content that would give a rocket scientist pause, then it might be easier to feel more at ease and less defensive with them. One of the purposes of this writing is to remind educational technologists of the immense task before them in that respect.

Finn's Criterion of Intellectual Theory Constantly Expanded by Research

Finn found the most important shortfall of educational technology in 1953 to be in the area of theory: its development and application. Specifically, he called for "an organized body of intellectual theory constantly expanding by research" (p. 7). Vincenti's knowledge category of theoretical tools seems most closely related to Finn's concern for a body of formal theory and an accompanying research process to extend it.

Theoretical Tools

Vincenti's category of theoretical tools includes "intellectual concepts for thinking about design as well as mathematical methods and theories for making design calculations" (p. 213). Vincenti points out the scope implied by these tools by explaining that "both the concepts and the methods cover a spectrum running all the way from things generally regarded as part of science to items of particularly engineering character" (p. 213).

Intellectual Concepts for Thinking About Design

Theory is an undeniable feature of the educational technology landscape, but it is a topic with which a surprising number of educational technologists feel uneasy. There are many attempts to define theory in relation to technological applications (Gibbons, 2014; Merrill, 1994; Reigeluth, 1983, 1999; Reigeluth & Carr-Chellman, 2009; Richie, 1986; Richie, Klein, & Tracey, 2011; Snelbecker, 1974; Snow, 1977).

Some link educational design directly to learning theory, while others propose that there is a species of theory especially suited just to designing. Most educational technologists are taught learning theory and told that it should be applied in designs, but there is little guidance in the educational technology literature about how to accomplish that. In the meantime, a body of literature has grown that prefers the term "instructional theory." It is hard to find a clear distinction between instructional theory and learning theory and how they differ in their impact on educational designs.

Strangely little of the publication on theory in educational technology literature has the flavor of a discussion. For example, surprisingly little attention is paid in the educational technology literature to early attempts to promote technological theory from noted authors such as Gage (1964), Bruner (1964, 1966), Glaser (1964), and Lumsdaine (1964). Some of these authors were writing within the paradigm of stimulus–response psychology, and some were not. Nonetheless, many of the observations from both sides sound almost current. For example, Bruner wrote, "a theory of instruction … is concerned with how one wishes to teach, with improving, rather than describing learning (Bruner, 1964, p. 307). Likewise, Gage stated: "while theories of learning deal with ways in which an organism learns, theories of teaching deal with the ways in which a person influences an organism to learn" (p. 268). Gage went on to propose that, "practical applications have not been gleaned from theories of learning largely because theories of teaching have not been developed" (p. 271). It is important to note that Skinner described his theory of reinforcements as an "instructional theory" rather than a "learning theory." Despite this, Skinner is taught as a learning theory in many graduate programs.

Individual expressions of instructional theory such as those of Merrill (2009), Mayer (2009), van Merrienboer (2007), and others are common. Reigeluth's theory books (Reigeluth, 1983, 1999; Reigeluth & Carr-Chellman, 2009) are an effort to unify theoretical concepts for practitioners. Likewise, Richie et al. (2011) attempt a synthesis. But there is little writing in the literature directed to practitioners about how to unify, connect, and compare theories on their own. Bostwick et al. (2014) attempt to address this issue. Uncertainties about theory seem to have a negative impact on practice. Research indicates that the average instructional designer tends to be confused about theory and tends to ignore the issue of theory, using instead models of other existing products (Cox & Osguthorpe, 2003; Rowland, 2008; Yanchar, South, Williams, Allen, & Wilson, 2010).

Finn was concerned with the state of theory in 1953. He stated that, "on the important test of theory the audio-visual field does not meet professional standards" (p. 15). The extra attention given to theory in this section is meant to illustrate that the degree of uncertainty about theory today may still be a concern. The trial-and-error methods of development predominant in 1953 continued to be embodied in the empirical methods for programmed instruction development of the 1960s, and they are apparent in the systematic design textbooks of today in the form of an emphasis on the tryout and revise cycle at every stage of development. The same design texts have less to say about the application of theory up-front in the design process that might shorten evaluation cycles and reduce the amount of reworking required. Finn criticizes the texts of his day because the theory they appealed to was fragmentary and did not include notions contained in the research literature.

Finn's concerns about research were equally strong. He notes that, "research pertinent to audio-visual education is published throughout the literature of the social sciences and need a staff of detectives to trace it down" (p. 15). His concern was that research results were "inaccessible to the practicing worker" (p. 15). He also noted the lack of evidence that research is influencing the formation of theory. He stated:

> The audio-visual field is in the peculiar position of having much of its research carried on by workers in other disciplines using hypotheses unknown to many audio-visual workers, and reporting results in journals that audio-visual people do not read and at meetings audio-visual people do not attend (p. 16).

In matters of theory and research, Finn contrasts the field of his day with other professional fields like medicine, finding this aspect of the field most lacking. If the state of the art today in research and the development of theory has changed, it is for the educational technology community to determine. As they consider this issue, this question may stimulate a conversation around this question:

- Does educational technology as a field hoping to be considered a profession have a clear concept of what theory is, what kinds there may be, how it is generated, how it relates to research, and how it finds its way into the practices of the average designer?

Quantitative Data

Vincenti points out that even when designers know how to design theoretically they must use materials that have properties that are best described in quantitative form: "such data, essential for design, are usually obtained empirically, though in some cases they may be calculated theoretically" (p. 216). For many educational technologists, their product is in one sense material—consisting of files, programs, and other resources—but in another sense immaterial—consisting of activities, events, and experiences. At the same time, new statistical and computer technologies are able to quantify properties of experience that were not possible 10 years ago. Advances in voice recognition permit the detection of stress; advances in visual analysis permit the recognition of faces and to some extent emotions expressed on faces; advances in statistical analysis permit the recognition of subtle patterns in user responding. These technologies and many others are in their primitive state, but emphasis on their development is high. As educational technologists consider these maturing technologies, they might ask questions like these: What variables of the learner might be useful to monitor and quantify? What kinds of algorithms will make these variables useful during and after instructional experiences?

Important Topics for Critical Analysis

As a core disciplinary activity, critical thinking can allow for greater understanding of the field's ideas and practices and facilitate progress in a number of areas. In this section, we suggest some of the areas of the field that would benefit from critical inspection of the sorts we have described here.

The Nature of Human Action

One area of the field that would benefit from critical analysis is assumptions regarding human action, and particularly, human motivation and agency. It seems reasonable to contend that, in order to help humans learn, designers and teachers should know what (or who) they are trying to help—that is, they need a viable concept of humanness and human learning. Some learning theories, for instance, have likened humans to animals (as in behaviorism) or machines (as in cognitivism. In both of these perspectives, human action is explained as being determined by environmental forces acting on individuals (Slife & Williams, 1995). It has been argued that his deterministic assumption, when adopted as the basis for practical design work in the field, often leads to products similar to what was witnessed in the early programmed instruction movement—an educational movement that ultimately failed (McDonald et al., 2005).

Previous writers within educational technology have encouraged both a search for a defensible philosophical foundation for the field (Evans, 2011; Jonassen, 1991; Spector, 2001) and consideration of perspectives that assume human agency instead of determinism (Jonassen et al., 1997). As a step in this direction, we recommend a careful examination of agentic and deterministic ways of conceptualizing humans and human learning, and particularly of how such conceptualizations might influence the design of instruction. For example, how might an instructional design be different if based on the assumptions of self-determination theory (Deci & Ryan, 2002), or some other agency-oriented perspective? Furthermore, if deterministic accounts of learners and learning eliminate the possibility for meaningful human action (Williams, 1992), then accounts of human agency and learning that emphasize that meaningfulness (e.g., Yanchar, Spackman, & Faulconer, 2013) may serve to stimulate further discussion of this issue. Critical examinations and discussions of these issues raise the possibility that agency and deterministic perspective can be better understood, applied, and tested in the context of educational technology. Such examinations offer practitioners and scholars in the field can then base their work on clearer views of human learning and human existence per se.

Inquiry Methods

Another aspect of the field that would benefit from such critical analyses are various conceptions of research and specific inquiry methods. If the purpose of educational technology is to help learners learn in some sense, then the way learners are conceptualized is key to how they will be studied. As a number of analyses have suggested, any method for studying the world will be based on assumptions and values regarding the target phenomenon and how it exists (Gadamer, 1989; Heideger, 1962; Slife & Williams, 1995; Yanchar & Williams, 2006); thus, an empirical method assumes empirical phenomena, a phenomenological method assumes intentional contents of consciousness, a narrative method assume narratively constructed life experiences, and so on. The logical extension of this basic insight is that a method will only produce findings that are consistent with its assumptions—empirical methods can only produce empirical findings, and so on. While this is obvious in some sense, it also suggests that, in a general way, use of any method ends where it begins—a notion that one observer referred to as the methodological circle (Danziger, 1985). While a study's findings are surely refined, clarified versions of the initial assumptions and hunches of researchers, and include the results of empirical tests, they are not capable of testing empiricism itself, because this assumption is presupposed in the very testing it performs.

Many methods commonly drawn from the social sciences, for instance, are based on the idea that human behavior, including learning behavior, is a lawfully governed phenomenon and should be studied with methods that are designed to provide explanations of the forces that cause human behavior to transpire in a given way under certain circumstances. These methods also commonly assume that what is real is what can be detected via the physical senses—that is, some sort of physical object or process—and thus all relevant phenomena are basically empirical in nature. If not strictly empirical, then a phenomenon of interest must be translated into some measureable operations that are empirical through the use of operational definitions. Thus, such methods—variations on the theme of experimentation—are based on determinism and empiricism, among other assumptions (Slife, 1998).

If scholars within educational technology use these methods, they are implicitly or explicitly engaging in a project that is based on these underlying assumptions; that is, they are using a method that is historically and philosophically designed to fit, and be effective, within a world in which empiricism and determinism are fundamentally real. The method is an appropriate choice for such a world because it was designed to be effective within it.

However, if scholars are not sure that this is the best way to conceive of human action and related phenomena such as learning, then they may wish to explore other inquiry approaches; and a primary way to conduct this exploration is by examining the assumptions of alternative methods, such as various forms of qualitative inquiry, design cases, and so on. While some of these alternative methods may already have been analyzed in this regard and have fairly well-studied assumptive groundings (e.g., phenomenology) that should be considered, others have not (design cases) and thus are in need of just this kind of examination. From our perspective, it is entirely within the purview of educational technology scholarship to perform these kinds of critical analyses. Moreover, resources that can facilitate this kind of examination are available in the social science (e.g., Slife & Williams, 1995; Yanchar & Slife, 2004) and education research (e.g., Paul & Elder, 2002) literatures.

Professionalism

Finally, in the spirit of Finn's call for professionalism, we briefly identify a number of activities that would allow for educational technology as a profession to be more self-critical and self-aware.

- To be aware of and draw an accurate and detailed history of its own past, its evolution, and its current issues and focusing questions.
- To critically reflect on its history, taking lessons from wrong turns and dead ends openly and honestly.

- To realistically appraise its current state of practice and its areas needing improvement.
- To provide a system for reviewing new ideas, testing them, and assimilating ones that pass the test.
- To revisit and reexamine the fundamental intellectual concepts and assumptions of the field periodically in the light of new knowledge produced in other fields.
- To help set profession-wide goals and voice its aspirations and vision, for the purposes of stimulating productive research and marking progress.
- To welcome and nurture innovative ideas, providing innovation forums where new concepts and processes can be proposed and tested.
- To provide channels to carry proven ideas, methods, theories, and processes from the laboratory into daily practice.
- To establish standards and levels for practice and methods for regulating and certifying members of the profession, including standards for training professionals.
- To provide impartial judging of professional communications, avoiding control of communications from falling into the hands of commercial, political, or social interests.
- To provide methods for detecting and sanctioning malpractice and unethical practices.
- To defend the distinction between professional practice and folk- or popular practice.
- To define acceptable research standards, adopting new methods and technical tools as soon as they are demonstrated effective and reliable.
- To constantly survey neighboring professional fields, investigating innovations, theory, knowledge, and regulatory methods that might be relevant.

Final Remarks

As we have suggested, the field of educational technology has many dimensions that are worthy of careful critical examination, the results of which would more defensibly ground the field philosophically, and strengthen the legitimacy of the field academically and professionally. However, critical analysis focused on personal as well as disciplinary assumptions can be difficult and demanding. It can be challenging for individuals to question their reasons for doing what they do, and in larger groups with a reasonably long institutional history, that tendency may be multiplied.

However, the process of training future instructional designers holds one potential key in helping the field to critically examine its practices. From our perspective, instructional design programs across the nation could include a course on such critical thinking in their curricula, and thus facilitate this important kind of inspection. However, we also suggest that Instead of teaching critical thinking in a single place in our curricula, opportunities for critical analysis could be embedded throughout the training of instructional design students. According to Wenger (1998), the generational encounter inherent in the training of newcomers to any community of practice can potentially both perpetuate past practices as well as introduce innovative insights. There is thus an opportunity for critical reflection and analysis of the field in every course of every instructional design program, and students in such critically focused programs could bring much to the field, and themselves be benefitted all the more by participating in this way.

Even if critical thinking of this sort cannot be adequately addressed in often-overburdened training programs, the pursuit of clarity, awareness, and self-examination can be a continual ideal toward which professionals in the field strive. The kinds of reflection we suggest, whenever they occur, and however they may be facilitated, are a major step in the field's progress into a future that calls for creative, forward-thinking educational technologists.

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