71 The Philosophy of Science and Educational Technology Research

Sebnem Cilesiz and J. Michael Spector

Abstract

Educational technology—the study and practice of using technology to support learning and instruction—is influenced by developments in various fields such as cognitive science, information and communications technologies, and psychology. To address the broad range of questions that make up the domain of educational technology research, a variety of approaches to scientific research are relevant. To facilitate the pursuit of a diverse research agenda relying on various approaches, we discuss scientific research in the domain of educational technology, present three philosophical approaches to scientific research that are relevant to educational technology research (namely, postpositivism, constructivism, and phenomenology) along with examples, and then discuss the larger landscape of approaches to scientific inquiry. With this, we aim to contribute to expanding the domain and diversity of scientific approaches within the discipline of educational technology, thereby informing and improving subsequent educational technology research.

Keywords

Constructivist epistemology • Philosophy of science • Scientific inquiry • Phenomenology • Postpositivist science • Research paradigms

Introduction

It was once noted that educational research has had little impact on improving learning on a large and sustained scale (Suppes, 1978). We believe similar concerns might be valid about educational technology research today. This is why we think it is appropriate to revisit the landscape of scientific inquiry within the context of educational technology research and why we hope that doing so will inform and improve subsequent educational technology research. Philosophy of science raises critical questions that inform educational technology research, including the following:

(a) Is there a proper domain of "educational technology research"? If so, how might that body of research be characterized and distinguished from other bodies of research that might also inform or influence educational technology practice?

(b) What critical features of research are commonly found in educational technology research? What forms of research and scientific perspectives are relevant to educational technology research?

We structure our discussion of the philosophy of science and educational technology research around these two broad questions. First, we attempt to define a domain of educational

S. Cilesiz (✉)
Department of Educational Studies, The Ohio State University, 29 West Woodruff Ave., 141 Ramseyer Hall, Columbus, OH 43210, USA
e-mail: cilesiz.1@osu.edu

J.M. Spector
Department of Learning Technologies, College of Information, University of North Texas, 3940 N. Elm St., G150, Denton, TX 76207, USA
e-mail: Mike.Spector@UNT.EDU

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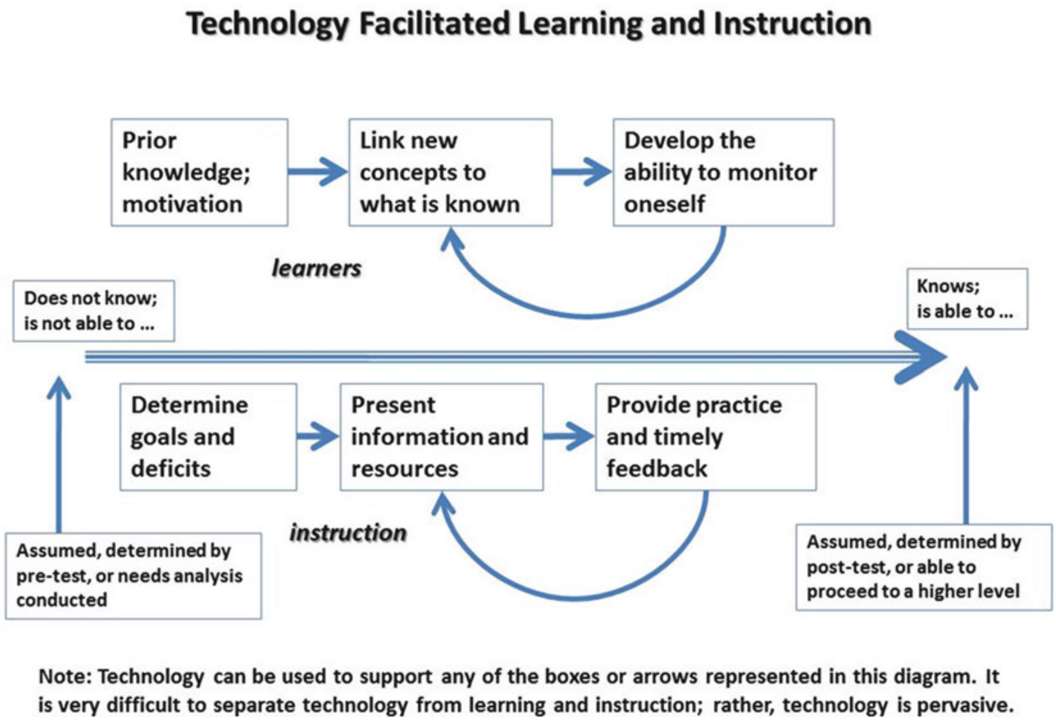

Fig. 71.1 Research on technology in learning and instruction (adapted from Spector, 2012)

technology research and define what constitutes scientific research. Second, we present three philosophical approaches to scientific research that are relevant to educational technology research, including examples. The first two approaches to scientific inquiry (i.e., postpositivism and constructivism) are the dominant approaches to address common research topics in educational technology. The third approach, phenomenology, is chosen as an example of a research approach that is currently not widely used, yet has the potential to address important questions in educational technology. Third, we place these scientific perspectives in the context of the landscape of approaches to scientific inquiry and discuss the current status and future potential for expanding the domain and diversity of scientific approaches within the discipline of educational technology.

We begin by defining the domain of scientific research in educational technology. Educational technology is defined as "the study and ethical practice of facilitating learning and improving performance by creating, using and managing appropriate technological processes and resources" (Januszewski & Molenda, 2008, p. 1). This definition can be interpreted in a number of ways; Fig. 71.1 depicts a provisional attempt to indicate the constructs that might properly constitute the core focus of scientific inquiry in educational technology, specifically research that is directly related to the practice of educational technology. Because one can use technology to support any and all of the boxes and arrows, in this and similar diagrams that represent learning and instruction, one could conclude that the focus could be on the efficacy or usefulness of those technologies. For example, one might use a pedagogical agent to help improve a learner's motivation (see, e.g., Kim, Keller, & Baylor, 2007); educational technology research pertaining to such a virtual agent might involve its impact on student achievement or attrition in online and blended learning environments.

One can conceivably ask many different kinds of questions about a variety of technologies used to support and facilitate learning and instruction. How these questions are formulated, and the approach to and process of resolving these questions depend on a clear definition of and approach to scientific inquiry.

Any discussion of the philosophy of science is related to a discussion of research itself. In the most ordinary sense, research is aimed at answering a question or resolving a problem. This broad definition of research would include a simple Internet search to find an isolated fact, such as the name of the person who wrote a book entitled *The Conditions of Learning*, because it involves an inquiry, an inquiry process, and a resolution. However, whether it qualifies as scientific research depends on how scientific research is defined. Not only is the definition of scientific research complex, but it is further complicated by its association with disciplinary traditions, politics, and historical contingencies. Not surprisingly, in the history of education as academic field, what counts as scientific research has always been contested (Lagemann, 2000); this longstanding contest is echoed in recent controversies surrounding national educational policies regarding the definition of scientific inquiry and its consequences for educational research (Denzin, 2009; Feuer, Towne, & Shavelson, 2002; Howe, 2009). Although it is contested by some (e.g., Denzin, 2009), the definition of scientifically based research provided by The American Educational Research Association (AERA) is used widely in the field. This definition includes eight characteristics: (a) logical, evidence-based reasoning, (b) appropriate methods for the questions posed, (c) observational or experimental designs that provide reliable and generalizable results, (d) data and analysis to support findings, (e) detailed elaboration of procedures used, (f) peer review, (g) dissemination of findings, and (h) access to and replicability of findings (AERA, 2008). This definition may be used widely because it is relatively broad and accounts for the fact that the nature of questions and problems studied are related to the kinds of research appropriate to study them.

Another essential characteristic of scientific research is its communal nature; researchers have questions and present findings that others can use and evaluate. Scientific research is also cumulative and progressive; it has the aim to improve knowledge over time as deeper and deeper insights into phenomena are gained and shared. For an inquiry to be considered scientific it is essential for it to be structured so that others can participate at some point—for example, by replicating the study, by critiquing the findings, or by extending the research in another direction. The notion of publicly accessible discourse is what helps to make science cumulative and progressive. Sharing ideas, which requires commonly understood discourse within a context of commonly understood frameworks, is essential for scientific progress. Thus, accepted ways of talking about the key questions and methods used to investigate those questions are essential for the progress of science.

Scientific inquiry is typically classified into three general types: basic research, applied research, or development research (e.g., NSF, 2012). Basic research questions are aimed at developing a fundamental understanding of new or unusual phenomena with no particular application in mind (e.g., What are the observable limits of working memory and do they vary based on age, experience, etc.?) and are typically explored using experimental research methods. Applied research questions aim to understand the extent to which the means intended to achieve a particular purpose are effective (e.g., To what extent does experience in using an interactive simulation in the domain of environmental planning improve the quality of decision making and problem solving in that domain?). Development research is aimed at understanding the use of particular systems and products, especially those that are new and innovative (e.g., How, when, and why do teachers make use of an option to personalize learning activities in a particular learning support system?). Some development research questions involve feasibility studies while others involve descriptive studies of the use of a new system. Often times, a new system is not used in the field in ways that designers originally envisioned, although this may not detract from its overall usefulness. Most educational technology research falls into the latter two categories—applied and development research. (For an overview of research designs for the most common research issues in educational technology, see Ross et al., 2007).

Research questions in the domain of educational technology can be explored using inquiry approaches that involve the characteristics of scientifically based research according to AERA, NSF, and other reputable sources. The particular approach to scientific research depends on the question asked and the purposes of research. Below we discuss three major approaches to scientific inquiry, which are appropriate for investigating questions in educational technology.

Postpositivist Science

According to this approach to scientific research, also called the hypo-theoretical model, scientific inquiry consists of a cycle involving such elements as (Duschi & Hamilton, 1992; Nagel, 1994; Scriven, 1960):

- Noticing an unusual phenomenon or encountering a new situation with unexplained attributes
- Reviewing relevant research and forming an initial hypothesis to explain the unusual phenomenon or as yet not understood situation
- Testing the hypothesis in some way, taking a closer look at the phenomenon or situation, and refining the hypothesis
- Sharing findings with others, reexamining assumptions and underlying theories, and possibly repeating the cycle

Although scientists may not always strictly follow these steps, but may rather jump from one activity to another or pursue multiple avenues of inquiry in parallel, forming and testing hypotheses are essential to postpositivist scientific inquiry. To clarify the process, let us begin with examining scientific hypotheses. What makes a statement or hypothesis a scientific statement or hypothesis in the postpositivist sense is that one could examine the facts and collect empirical data to determine whether the statement is true or false—put differently, whether the hypothesis was supported of falsified (Popper, 1963). Popper (1963) argued that the notion of falsifiability was a stronger notion than that of verifiability, meaning empirical observations could more easily serve as counterevidence to a hypothesis. This also implies that a scientific claim has to run the risk of being shown to be false or unjustified under public scrutiny. This model of scientific inquiry is referred to as the postpositivist model. In order for scientific progress to occur, there needs to be scientific discourse among people; if two individuals are engaged in an

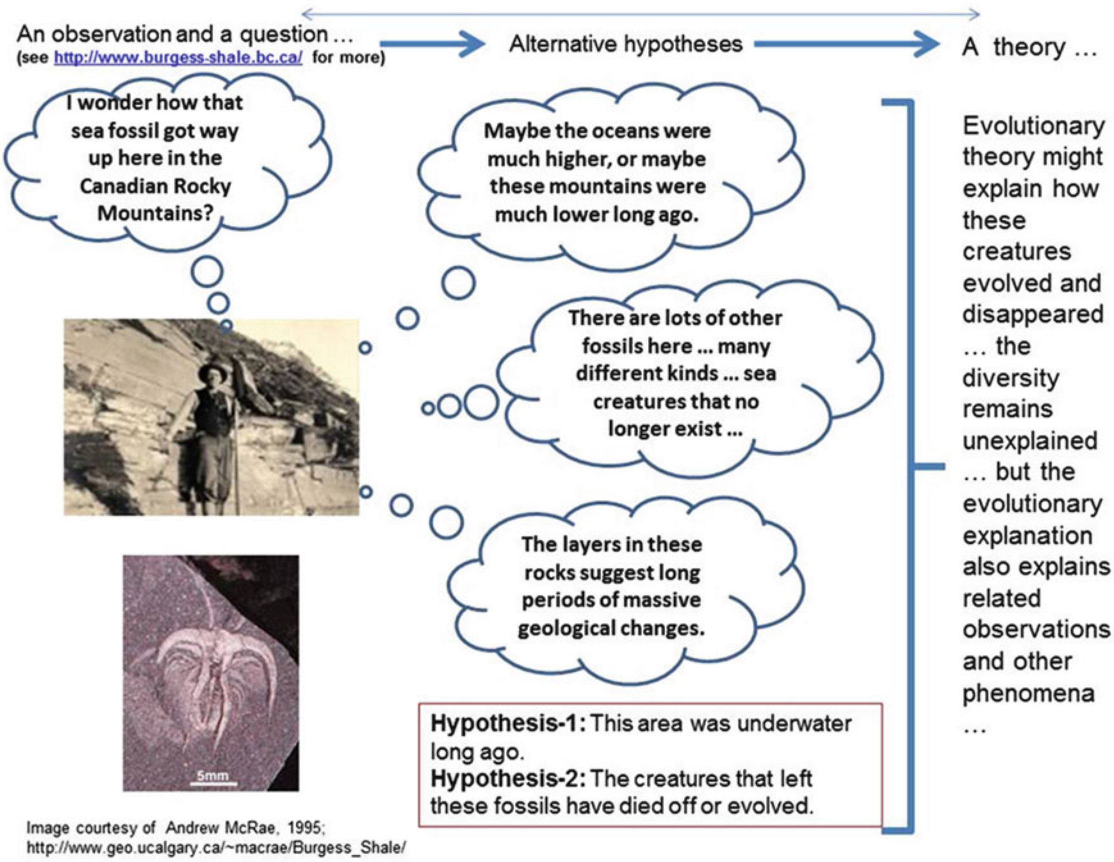

Fig. 71.2 A representation of forming scientific hypotheses (adapted from Spector, 2012)

apparently scientific discourse about something they must both allow any observations to count against their claims. Suppose someone finds unusual fossils in the Canadian Rocky Mountains (see Fig. 71.2).

One might ask how the fossils got there. Another might answer, for example, that God had put them there. Such a response is neither refutable nor verifiable and is therefore not suitable for scientific discourse. For the discourse to be a scientific discourse, a different kind of response is required. Perhaps this matter was not a mountain thousands of years ago, but had been under water in the middle of an ocean. This could raise the question of whether the Earth can really change that radically. Such a possibility is supported by other evidence at other locations. For example, geological evidence suggests that the Grand Canyon did not start out as a canyon a mile deep but that it took millions of years to form. If such changes are possible, then perhaps millions of years ago, the area in which the fossils were found in Canada was under water. For further investigation, the fossils are sent to a reputable and experienced marine biologist, who reports that there is no living creature that matches the fossil. This is additional evidence that the fossil was left behind a long time ago—so long that the species has died off. The claim that species disappear is acceptable as there are familiar examples of endangered species within our common experience today. Carbon dating may provide further evidence that the fossil is very old. In sum, evidence can be collected and observed by a group of investigators to confirm, or potentially refute, the hypothesis in question.

A postpositivist understanding of scientific inquiry assumes that observations and the formation of hypotheses can be objective, provided principles of scientific inquiry are followed. However, values, predispositions, and habits influence the observations we make and the hypotheses we form. Nevertheless, in order to make progress in understanding our world, we need a commonly accepted language to discuss findings and formulate hypotheses, and we need a commonly accepted framework within which to proceed. A constructivist epistemology takes these into account in its approach to scientific inquiry.

Constructivist Epistemology

The terms constructivism and constructionism are frequently used to refer to an epistemology (i.e., beliefs about knowledge and how we come to know) or a learning theory (i.e., a theory about how people learn). In various streams of literature, it is possible to find either word referring to either concept. Adding to the confusion is the fact that these words are sometimes used interchangeably to refer to the same concept. To clarify our focus here, we would like to distinguish between the epistemology and the learning theory. The latter concept is based on Papert's (1980) belief that knowledge is effectively developed through the construction and manipulation of objects, artifacts, or even concepts (for a discussion of constructivism as learning theory in educational technology see, e.g., Duffy & Cunningham, 1996; for an overview of various philosophical perspectives and their relationship to theories of learning see Schuh & Barab, 2007). Here, we use the word "constructivism" to refer to the former concept, constructivist epistemology. Constructivism as an epistemological position is often linked back to Piaget's (1950) basic idea that learners construct knowledge through active involvement with and interpretation of that individual's experiences, as well as to similar positions in the works of Kant and others centuries earlier. Relatedly, social constructionism maintains that reality is constructed through social interaction (Berger & Luckmann, 1967). One foundation for constructivist epistemology can be found in the work of the Austrian philosopher Ludwig Wittgenstein. In the *Tractatus Logico-Philosophicus* (Wittgenstein, 1922), Wittgenstein makes the apparently simple observation that we picture facts to ourselves. We create internal representations of things we experience—especially puzzling things or things we have not previously experienced. We construct internal representations that serve us as interpretations of our experiences. This is something a person does naturally and often without any conscious or deliberate effort, as part and parcel of being human.

The second component of a constructivist epistemology can be found in Wittgenstein's posthumously published *Philosophical Investigations* (Wittgenstein, 1953), in which he introduces the concept of a *language game*. Language games involve rules which a community of users generally accept and follow, and they involve family resemblances between and among terms. Wittgenstein pinpoints forming and testing hypotheses as an example of a common language game in the scientific community. A language game not only creates internal representations of things we experience, but also enables us to talk about those representations with others. Internal representations are thereby externalized, shared, and submitted to the court of public scrutiny. The notion of a shareable language is essential if one is to avoid the solipsism (one can only know one's own thoughts) that is sometimes associated with radical constructivism. What is useful is the naturalistic approach to epistemology found in Wittgenstein and in Piaget, meaning that we naturally and without prompting create internal representations and share them with others in the form of language, drawings, constructed artifacts, and so on. Because this process is ongoing and natural, the focus is on the individual and not the outside environment. Individuals construct internal representations in any learning environment—indeed, in any environment, and they occasionally share them with others regardless of any particular aspects of the learning situation or environment. For educational researchers, what matters is the extent to which those internal representations and the sharing that involves them supports or leads to desired learning outcomes. That is something that can be measured although doing so is not always an easy task (Pirnay-Dummer, Ifenthaler, & Spector, 2010; Spector & Merrill, 2008).

Overall, constructivist epistemology has added alternative insights and a particular way of talking about (i.e., a language game) research in educational technology. Constructivist epistemology is not in direct opposition to earlier accounts of learning and instruction; rather it provides new and insightful ways to discuss core topics in educational technology, such as the conditions of learning. A typical interpretation of Gagné's (1985) work is that effective instruction includes a certain set of events (e.g., gaining attention, reminding learners, stating goals and objectives, presenting information, providing learning support, providing opportunities for practice, providing meaningful and timely feedback, assessing performance, promoting transfer of learning to new situations). A constructivist perspective on this theory would suggest that engaging learners actively in setting goals or asking learners to reflect on and assess their own progress are likely to promote learning. For example, in the product developed around Gagné's nine events of instruction called GAIDA (Guided Approach to Instructional Design Advising) (Spector, Polson, & Muraida, 1993), the nine events are not regarded as a linear sequence or a set of discrete events but characterized in terms of common clusters (set-up, primary instruction, and resolution) that could occur in any order and recur several times within a unit of instruction. While GAIDA was focused on instructional designers and instructors, the rationale provided for the design was most often focused on learners, learning activities, and how what learners did was likely to result in targeted outcomes (Spector et al., 1993).

Constructivist approaches to educational technology research are more explicitly focused on how learning develops within particular learners in various situations, considering all perspectives—the learner perspective, the instructor perspective, and the design perspective—and the interactions among these. For example, evaluating implementations of innovative educational technologies or systems is a rich area of research and overtly aims to integrate the three perspectives (i.e., learner, instructor, and design), and can do so from a constructivist perspective. Thus, we discuss program evaluation as an area of development research in educational technology and provide an example below. At the heart of program evaluation are basic questions such as whether and to what extent an intervention (e.g., an innovative technology or new learning

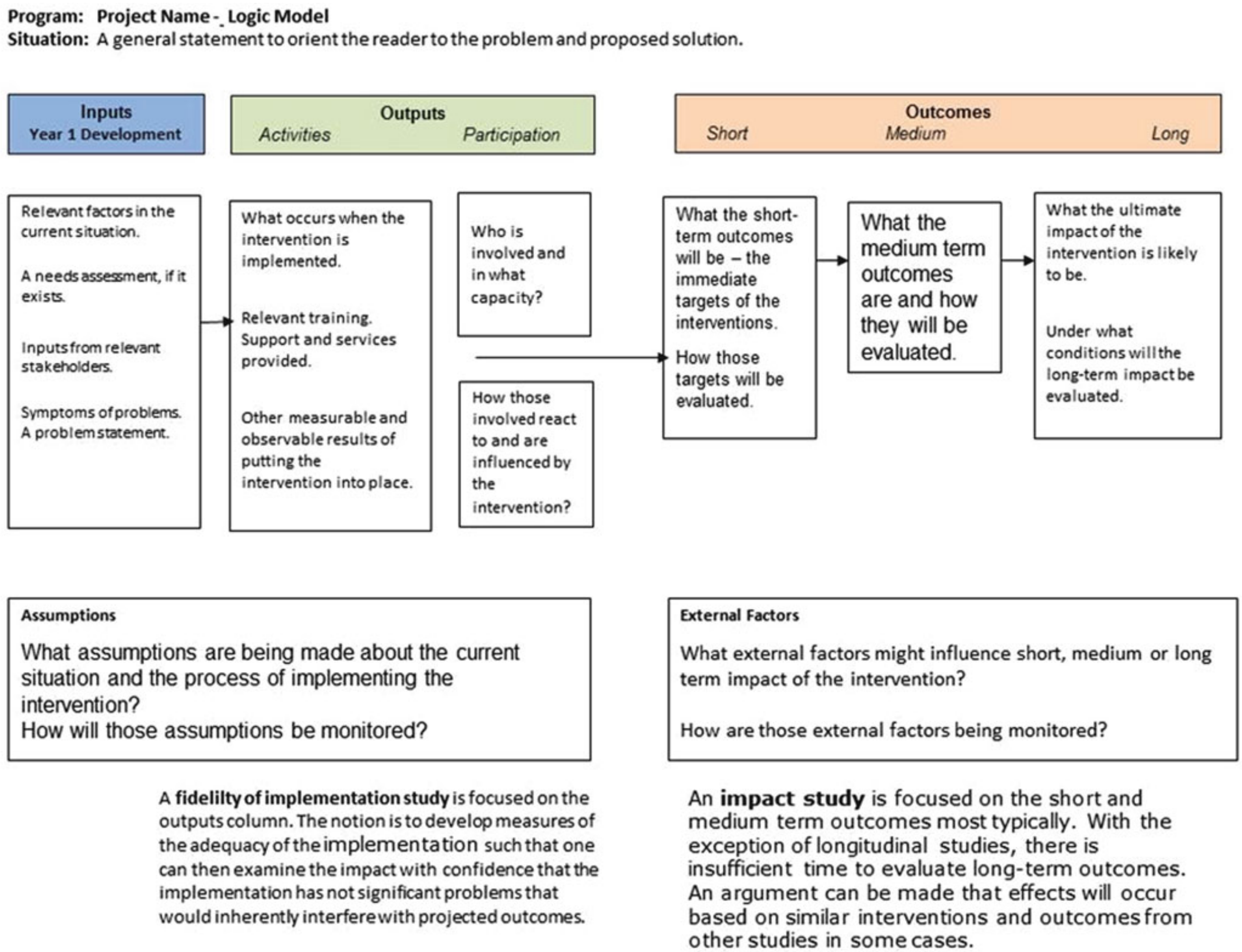

Fig. 71.3 Logic models, fidelity of implementation, and impact studies (adapted from Spector, 2012)

environment or educational system) achieves its intended aims, and why it succeeded or fell short in some way. Within a logic model (see Fig. 71.3), an evaluation study can include a fidelity of implementation study, an impact study, or both.

As Fig. 71.3 shows, a logic model portrays a current situation and the associated problem, implementation of an intervention intended to address the problem situation, and the projected or predicted outcomes and benefits of that intervention if successfully implemented. A theory of change that explains why and how the intervention would lead from the problem state to the desired outcomes is normally associated with a logic model. A fidelity of implementation study could be structured such that the results of the study reflect degrees of successful implementation (as in high, medium, low, or superior, adequate, marginal for such variables as professional development and technology support). Having such data is useful in explaining why (or why not) and to what extent significant differences were found in outcome variables. For additional detail on such studies, see the chapter by Jennifer Hamilton in this Handbook.

We would like to further explain program evaluation through a hypothetical research example. We first describe a development case and then continue on with a fictitious research example (intended for purposes of illustration) that could have been conducted as evaluation research. The setting is the US Air Force Academy (USAFA) located just North of Colorado Springs, Colorado. The time frame is the 1980s. The problem situation is that a large percentage of cadets were changing their major from aeronautical engineering to something else after taking the first aeronautical engineering course. Indeed the second author was a cadet who did just that in 1963, so this situation had been developing for some time. The Academy wanted the majority of its graduates to have a major in aeronautical engineering—that goal was not being met and had not been met for many years. A study was conducted to determine what might account for the massive rate of change in majors after the first course. First, a needs assessment was conducted that included classroom observations and interviews with cadets. The symptom (high rate of changes in major) was linked to the nature of the aeronautical engineering course. It was being taught as a drill and practice class, where students had to memorize formulas and then plug numbers into the formulas to calculate values. In the 1960s slide rules were used for those calculations; in the 1980s cadets had personal computers available, but the reports of boredom with the drill and practice nature of the course did not change.

That analysis led to the conclusion that the course was not motivating or sufficiently engaging for USAFA students. A theory of change evolved that hypothesized that allowing students to design and test artifacts would result in increased engagement and motivation and result in lower rates of change to another major. The implementation that became the focus of the intervention involved a series of increasingly challenging interactive simulations—students formed small groups and designed engines and other aircraft components and tested them to see which ones were the best according to the relevant aeronautical criteria. There was a companion textbook written to accompany the simulation-based learning environment, and all of the components were built into an electronic environment and could be searched by topic, keyword or chapter.

The implementation involved training of all aeronautical engineering faculty on the new learning environment and its intended use. Incidentally, a fire destroyed all of the textbooks before they could be delivered to USAFA. This could be categorized as an external event that might have affected the outcomes. As it happened, there was no known effect on outcomes since the entire textbook was available electronically, in a form more usable than a textbook. Typical assumptions about the timeliness of the delivery, appropriate support and so on were satisfied, although not without enormous effort on the part of USAFA faculty and support personnel. There was an analysis of outcomes, although its results were not formally reported. USAFA uses standardized end-of-course tests and had available approximately 30 years of data on the standardized test for the first aeronautical engineering course, along with a great deal of other information on USAFA cadets over that 30 year period of time. The analysis revealed no significant difference in terms of performance on the end-of-course test of the impact of the new design compared with the previous design. This outcome might be disappointing from the perspective of implementing an innovation. In fact, the test had not been changed to test the kinds of things that might have been learned in a simulation-based problem-solving environment as opposed to a drill and practice classroom environment. However, analysis on the primary outcome—those changing majors after that first aeronautical engineering course—did reveal a significant difference. The course had the desired outcome of dramatically lowering the rate of change for those dropping the aeronautical engineering major.

This development at USAFA had all the aspects of a development research project. The needs assessment was extensive and informed the theory of change based on experiential learning. A fidelity of implementation study would have made explicit the fact that much of the training and preparation occurred with rushed schedules and non-standard training of faculty. Nevertheless, an impact study would have yielded positive outcomes. Moreover, further research could explore effects on student understanding of complex problems, using a technology such as that reported by Pirnay-Dummer et al. (2010). Then, similar implementations in other subjects as well as at other institutions could be studied. In this way, such a research project would add to the knowledge of what works in various learning situations and satisfy the requirement of scientifically based inquiry to be cumulative. Furthermore, by replicating the implementation at other institutions and with other subjects, the generalizability of the findings could be subjected to public scrutiny, another critical feature of scientific inquiry.

So far, we have reviewed the postpositivist approach and constructivist epistemology as approaches to scientific inquiry that can be used in educational technology research, providing specific examples. Indeed, these approaches can and do address common problems that lie in the core domain of research in educational technology, as we have described above (see Fig. 71.1) (Ross et al., 2007). While important and useful, these types of scientific inquiry do not address all problems relevant to educational technology. Educational technology research is also concerned with some outcomes that are not immediately measurable, such as long-term outcomes; emotional, social, cultural, political, and aesthetic qualities of experiences; and processes of teaching and learning (Parrish, 2009). Views of scientific inquiry that emphasize such foci in educational domains are important additions to established research in educational technology that intends to identify causal relationships, predict, or evaluate outcomes. To give an example of such an approach, we explain phenomenological research below. Phenomenology is especially suited to this chapter due to its origins as a philosophical analysis method. Moreover, phenomenology is a promising approach for the pursuit and advancement of educational technology research (Cilesiz, 2011).

Phenomenological Research

Phenomenology is rooted in the work of German philosopher Edmund Husserl (Husserl, 1969, 1970a, 1970b); other philosophers who built on his work include Heidegger, Merleau-Ponty, Gadamer, Ricoeur, Sartre, and Schutz. Phenomenology originated as a method of philosophical analysis and was consequently applied as research methodology in disciplines such as psychology, nursing, and education. Currently, it is both a philosophical approach and a social science research methodology, founded on a specific (phenomenological) conceptualization of experience (for a depiction of a phenomenological concept of experience see Cilesiz, 2011). In order to conduct a rigorous phenomenological study, one must understand its philosophical underpinnings and presuppositions (Giorgi, 1997), therefore we begin with a brief description of the philosophical foundations of phenomenology.

Phenomenology is based on Cartesian dualism, emphasizing simultaneously that a world of objects exists without humans' consciousness, waiting to be discovered and that the external world is not independent of cognizant minds; from the perspective of phenomenology, conscious subjects and their objects are separate, yet they interact, and meaning can be found in this relationship (Husserl, 1982). Epistemologically, phenomenological inquiry is concerned with the essences of ideas; however, essences are manifested in and can only be known through conscious experience, which has both a material dimension and an ideal dimension. Essence refers to the condition or quality of an experience that is common or universal; it is what makes an experience what it is and without which an experience would not be what it is (Husserl, 1969).

Phenomenological research aims to develop an in-depth understanding of individuals' lived experiences of a phenomenon from the perspective of those who experience it, thereby producing in-depth descriptions of essential structures of the phenomenon. In doing so, phenomenological inquiry aims to obtain descriptions of subjective experience without questioning their causes or whether they correspond to an independent reality. Consistent with this epistemological position, phenomenological research makes it possible to generate plausible insights through direct contact with phenomena rather than aiming at empirical generalizations, establishment of functional relationships, or development of theory with which to predict or control. To do justice to investigating subjective experience, a phenomenological researcher is supposed to have an unadulterated mind, refraining from any judgments about the correctness or falsity of a research participant's claims regarding his/her *lifeworld*, rather engaging in a deliberate, disciplined, and systematic effort to suspend his/her natural standpoint about the phenomenon of study (Husserl, 1969, 1970b).

How does and can the field of educational technology benefit from the pursuit of phenomenological research? In one sense, phenomenology is the study of the *lifeworlds* of individuals, meaning "what we know best, what is always taken for granted in all human life, always familiar to us in its typology through experience" (Husserl, 1970a, pp. 123–124). Technologies, old and new, are ubiquitous elements of modern life and thereby education, thus humans' experiences with technology are part of their lifeworlds. The mundane is the domain of phenomenological research, and most technologies are seamlessly integrated into people's daily lives.v Therefore, investigating people's experiences with technology, both in teaching and learning, and in everyday life, is consistent with the goals of phenomenological research. Examples of phenomenological research in educational technology include studies on adolescents' experiences of educational computer use in informal learning environments (Cilesiz, 2009) and experiences of adult first-time computer users (Howard, 1994). Cilesiz (2011) provides a discussion of the suitability of phenomenology in educational technology research and suggests several research directions for phenomenological research in educational technology. Below, we provide an example of a research scenario using phenomenology to approach an educational technology research topic.

Assume a researcher is interested in understanding the experiences of novice computer users and aims to understand the process of learning to use computers as well as the feelings associated with the process in order to develop proper support programs for such users at a community technology center. The researcher can use a phenomenological philosophical approach and research methodology. First the researcher would suspend his/her presuppositions about novice users' experiences. He/she would avoid drawing on his/her own experiences with learning to use computers, which may have been pleasant and exciting due to availability of material resources and supportive and knowledgeable parents. Likewise, he/she would refrain from drawing on his/her assumptions based on others' accounts of their experiences or knowledge from the academic literature that novice users are supposed to feel anxiety and/or ambivalence about learning to use computers. The researcher would design the study consistent with the philosophical foundations of phenomenology, recruit participants who have significant experiences of the phenomenon, and arrange interviews with them. Once data collection is underway, the researcher would continue to suspend his/her previous knowledge or assumptions about novice computer users so as to be able to hear fully the participants' experiences, avoiding any premature conclusions. He/she would retain a focus on the participants' descriptions of their experiences rather than making factual claims about these statements. For example, the researcher could state that the participants *expressed* anxiety about learning to use computers rather than stating that participants *felt* anxiety about learning to use computers. To the extent that the researcher can record whether the participants were anxious or not, these would have to depend on direct observations, and this type of researcher judgment is not consistent with phenomenological research. The researcher would collect descriptions from the participants, look for shared structural similarities in experience, and would produce a textual description of the essence of the experience of learning to use computers as the output of the study.

Conclusion

This discussion of philosophical approaches for scientific inquiry as it pertains to educational technology research has had three objectives. First, we demonstrated that consideration of philosophy of science is useful in helping to improve scientific inquiry in the area of educational technology. We provided a definition of the domain of educational technology research and described philosophies of science and scientific research as they relate to educational technology; our goal was to evoke consideration of the broad range of questions that make up the domain of educational technology research and the variety of approaches to scientific research available to address these issues. We hope that readers and researchers will be more firmly grounded in the scientific enterprise, recognizing its diversity, and, as a result, conduct more rigorous studies that add to our knowledge and push educational technology research forward. We believe our discussion emphasizing the interrelation between scientific approaches and the types of questions they can address within the domain of research in educational technology can help improve the scientific basis of the field.

Second, to facilitate the pursuit of a diverse research agenda relying on various approaches, we presented three philosophical approaches to scientific research that are relevant to educational technology research—both dominant approaches (i.e., postpositivism and constructivism) and promising approaches currently not widely used (i.e., phenomenology). We also provided examples of the types of research that these approaches could address. Different approaches to scientific inquiry are available and are suitable for different research objectives, and appropriate methods of inquiry (qualitative, quantitative, or a combination) can be identified according to specific research questions (Creswell, 2007; Crotty, 1998; Spector, 2007). Our goal was to demonstrate both the availability of various approaches to science and facilitate the identification of a suitable approach for any given question, thereby enabling researchers to reach their research goals as well as leading to the utilization of a wide variety of approaches in the field.

Our third objective was to discuss the larger landscape of approaches to scientific inquiry in educational technology. Certainly the approaches we have discussed in this chapter do not capture the paradigmatic and epistemological diversity available in scientific inquiry; it is important to place them in the context of the larger landscape of scientific inquiry. Although philosophical orientations of instructional designers and researchers in the field gravitate toward certain approaches (e.g., pragmatic) while being less accepting of others (e.g., critical) (Sheehan & Johnson, 2011), there is nonetheless some variation in approaches to scientific inquiry used in educational technology. In addition to commonly used approaches and methodologies, recent literature has discussed the use of qualitative research in general (Savenye & Robinson, 2004) as well as specific methodologies such as conversation analysis (Mazur, 2004), phenomenology (Cilesiz, 2011), and philosophical inquiry (Koetting & Malisa, 2004) in educational technology. Moreover, there are discussions around more marginal approaches such as those advocating critical theory (Nichols & Allen-Brown, 1996) or poststructuralism (Hlynka, 2004; Solomon, 2000; Yeaman, Hlynka, Anderson, Damarin, & Muffoletto, 1996) as well as those advocating a critical-realist agenda to resist the postmodern agenda (Evans, 2011). Our discussion of examples of scientific approaches as well as the larger landscape of approaches to scientific inquiry in educational technology has the intention of promoting further discussion along these lines. We believe that such discussions are fruitful as they can raise awareness of researchers regarding their contributions to the field and facilitate higher acceptance of a wider range of approaches, which in turn would advance the field as a whole and strengthen its scientific basis.

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