Knowledge building for use of the internet in education

CHARLES M. REIGELUTH

Department of ducation, Education 2236, Indiana University, Bloomington Campus, 107 S. Indiana Ave., Bloomington, IN 47405-7000, USA

Abstract. The purpose of this commentary is not so much to critique the studies in this special issue as to stimulate deeper thinking and dialogue about the issues raised by these studies, in the hope of improving the usefulness of research in this important area. The key issues are represented by the following three questions: 1) What kind of knowledge is needed for how to use the Internet most effectively for educational purposes? 2) What kind of research is needed to generate that knowledge? 3) What role should technology play in the nature of that knowledge? In addressing these questions, this article explores the value of design theory relative to descriptive theory. It explores the value of design-based research relative to descriptive and comparative studies. And it explores the value of integrating technology into the methods we have traditionally used in education relative to harnessing technology to transform those methods into ones more focused on learners' needs.

The common goal of the five studies reported in this special issue is to help figure out how to use the Internet better for education. This presumes the purpose of building a common knowledge base about such use. The purpose of this commentary is to stimulate a dialogue among researchers about building this kind of knowledge base, rather than to critique the studies in this issue. As I read these five studies, I found three questions emerging in my mind about building such a common knowledge base:

1. What kind of knowledge is needed to build that knowledge base?
2. What kind of research is needed to generate that knowledge?
3. What role should technology play in that knowledge base?

These three questions are addressed below.

What kind of knowledge is needed?

Descriptive vs. design theory. Herbert Simon (1969) made an important distinction between the natural sciences, which provide descriptive theory, and the sciences of the artificial, which provide design theory. Descriptive theory focuses on identifying reliable cause-effect relationships or natural processes, whereas design theory focuses on identifying the best means to

accomplish goals. Descriptive theory is the result of what Cronbach and Suppes (1969) call conclusion-oriented inquiry, and design theory is the result of what they call decision-oriented inquiry. The Design-Based Research Collective (2003) indicates that design theories in education "provide detailed guidance in organizing instruction" (p. 10). For more on the distinction between descriptive and design theory, see the first few pages in chapter 1 of my book on instructional-design theories (Reigeluth, 1999).

Given the desire to build a knowledge base about how to use the Internet better for education, does it make sense that design theory will be the most useful for practitioners? Of course, descriptive theory can help both to construct design theory and to provide a rationale for why design theory "works." But, it seems that researchers should focus primarily on developing design theory if their goal is to generate knowledge to help educators use the Internet effectively.

So do these five studies (and others typical of the area) generate design theory? To answer this question, it is helpful to get a clearer understanding of what makes up a design theory. Basically, such a theory has two major elements: what methods to use and when to use them (Reigeluth, 1999). Let's address the issue of methods first.

Methods. The tricky thing about methods is that they have parts, which are also methods, and they in turn have parts, and so forth. Macro methods are comprised of mini methods. This means that, for example, problem-based learning (PBL) in one study may be very different (have different mini methods) from PBL in another study. Therefore, results of studies that compare PBL with traditional instruction are unlikely to hold true in other applications where the methods may vary substantially. Furthermore, even if fantastic advantages are found for using PBL in such a study, we have no idea which of the mini methods actually accounted for those positive effects.

For both these reasons, it is important that studies look at the effects of each mini method. However, mini methods often have "interaction effects" with other methods. In other words, the effects of each mini-method are usually interdependent with the other mini methods that are used, as well as contextual factors. Thus, the decision-oriented design theories we build need to take these interdependencies into account, and the research methods we use need to be appropriate for generating such knowledge. Do these five studies generate such knowledge? I leave it to the reader to reflect back on the studies to answer this question.

When to use the methods. In chapter 1 of my book on design theory (Reigeluth, 1999), I label "when to use the methods" as situations and identify

several kinds of situations: conditions, desired outcomes, and values about instruction. I also identify "preconditions" (which would actually be better labeled "presituations"), which indicate when a whole design theory should and should not be used. The Recker et al. study does a nice job of identifying presituations for use of their approach (set of mini methods). Do any of the other studies address this issue?

After a design theory has been selected for use, it would be rare for it to always recommend using exactly the same methods in the same way for all situations. Therefore, to generate useful design theory, a study should attempt to identify when and when not to use each of the mini methods that comprise the design theory. This means that design theory should specify situations for use of each mini method. Did these studies attempt to build such knowledge?

Dialogue. Given the distinction between descriptive theory and design theory, it seems that design theory is more useful to help practitioners use the Internet in education. So why are we researchers not devoting more of our efforts to developing design theory? Is it because we don't realize its greater value? Is it because we don't know how to develop such theory? Is it because we suspect that journals won't publish such scholarly work? Perhaps our field could benefit from more dialogue about these questions. Without such reflection, educational research may continue to be perceived as of little value by most practitioners (National Research Council, 2002).

If design theory is important to generate, then a second question becomes important.

What kind of research is needed to generate that knowledge?

Comparison vs. improvement. For descriptive theory, the major research focus is comparing methods to see which one works better, whereas for design theory the major research focus is improving methods and improving our understanding of when and when not to use methods and mini methods (situations). In the early stages of knowledge development in an area (such as use of the Internet in education), improving the fledgling methods we have, and figuring out when and when not to use each, are likely more valuable than comparing them to traditional methods. In fact, the Design-Based Research Collective (2003) states, "The use of randomized trials may hinder innovation studies by prematurely judging the efficacy of an intervention" (p. 6). Do these five studies focus primarily on comparison or improvement? Do some of them talk about improvement but use methods that focus on comparison? Did one use an iterative design approach that focused some attention on improvement?

Research for improving methods differs considerably from research for comparing methods. It constitutes a fundamental shift in research methodology that is akin to the difference between formative evaluation and summative evaluation (Design-Based Research Collective, 2003; Reigeluth & Frick, 1999). Research to generate descriptive knowledge is primarily concerned with the validity or truthfulness of the descriptions. In contrast, research to generate design knowledge is primarily concerned with preferability or usefulness. Design knowledge is goal-oriented, and there are always at least several ways to attain a goal. All of those ways are valid in the sense that with enough time, energy, and motivation, they can result in attainment of the goal. Practitioners and design-theory builders are interested in which of those ways is best, given their situations (their conditions and the criteria they value). This requires research methods that seek to enhance preferability rather than validity. Such methods include developmental research methods (Lijnse, 1995), grounded theory development methods (Glaser & Strauss, 1967), design experiments (Brown, 1992), and formative research methods (Reigeluth & Frick, 1999).

A recent special issue of the *Educational Researcher*, titled "The Role of Design in Educational Research" (Kelly, 2003) provides considerable support and prestige for the use of "design-based research" or "design experiments" to generate useful knowledge in education. In that special issue, the Design-Based Research Collective (2003) states that "... the overarching, explicit concern in design-based research for using methods that link processes of enactment [methods] to outcomes has power to generate knowledge that directly applies to educational practice" (p. 7). In another article in that special issue, Cobb, Confrey, diSessa, Lehrer and Schauble (2003) state that an "intimate relationship between the development of theory and the improvement of instructional design for bringing about new forms of learning is a hallmark of the design experiment methodology" (p. 13).

Dialogue. Research to *prove* investigates what's best among what we already know how to do, whereas research to *improve* investigates how we can improve on what we know how to do. The special issue of the *Educational Researcher* attests to growing recognition that the latter is likely to be more valuable to develop design theory, such as that needed for using the Internet in education. Then why are we researchers not devoting more of our efforts to this kind of research? Is it because we haven't been trained to do it? Is it because the US Department of Education has recently developed a policy to fund primarily experimental research (Erickson & Gutierrez, 2002)? Is it because Journals tend to publish descriptive studies (both experimental and qualitative), even when the knowledge they contribute has minimal useful-

ness for educators? It would be nice to blame the reviewers, but we are the reviewers. Many of us were schooled in a research methodology that is based in a Cartesian, mechanistic view of the world (Ackoff, 1981) that places much more value on experimental research than design-based (or formative) research. Perhaps our field could benefit from more dialogue about these questions, too.

Technology for integration or transformation?

The third question that occurred to me as I read the five studies in this special issue is, "What role should technology play in the knowledge base we are generating about use of the Internet in education?" The term, "technology integration," implies the use of technology to enhance what we are doing in the classroom. But technology in general, and the Internet in particular, allow us to use methods that weren't possible before (Reigeluth & Joseph, 2002). The history of innovation shows that typically a new technology is initially used within traditional work processes, but that over time it is used to fundamentally change the work processes in a way that provides a quantum improvement in the ability to meet our needs. This implies that perhaps the most valuable research studies will be those that help us to develop very different methods to facilitate learning with the Internet.

Do these five studies help generate such knowledge? Should we researchers devote more attention to generating such knowledge? Perhaps our field could benefit from more dialogue about these questions, too.

Conclusion

As stated in my introduction, the purpose of this commentary is not to critique the studies in this issue, but to stimulate a dialogue among researchers that may help to shape the direction of future research in this important area. The studies in this issue are fairly typical of much of the research that is done in the broader areas of educational technology and instructional science. It may do much to advance the field if we researchers devote some of our energies to contemplating:

- the kind of knowledge that is most important for us to generate (descriptive or design theory),
- the kind of research that is most useful for generating that knowledge (research to compare or research to improve), and

- the role technology should play in that knowledge base (to merely be integrated into the way we currently teach, or to transform the way we teach).

References

Ackoff, R.L. (1981). *Creating the Corporate Future*. New York: John Wiley & Sons.

Brown, A.L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *Journal of the Learning Sciences* 2: 141–178.

Cobb, P., Confrey, J., diSessa, A., Lehrer, R. & Schauble, L. (2003). Design experiments in educational research. *Educational Researcher* 32(1): 9–13.

Cronbach, L.J. & Suppes, P., eds (1969). *Research for Tomorrow's Schools: Disciplined Inquiry for Education*. New York: Macmillan.

Design-Based Research Collective (2003). Design-based research: An emerging paradigm for educational inquiry. *Educational Researcher* 32(1): 5–8.

Erickson, F. & Gutierrez, K. (2002). Culture, rigor, and science in educational research. *Educational Researcher* 31(8): 21–24.

Glaser, B.G. & Strauss, A.L. (1967). *The Discovery of Grounded Theory; Strategies for Qualitative Research*. Chicago; New York: Aldine Pub. Co.

Kelly, A.E. (2003). Research as design. *Educational Researcher* 32(1): 3–4.

Lijnse, P.L. (1995). "Developmental research" as a way to an empirically based "didactical structure" of Science. *Science Education* 79(2): 189–199.

National Research Council, ed. (2002). *Scientific Research in Education*. Washington, DC: National Academy Press.

Reigeluth, C.M. (1999). What is instructional-design theory and how is it changing? In C.M. Reigeluth, ed., *Instructional-Design Theories and Models: A New Paradigm of Instructional Theory*, Vol. II, pp. 5–29. Mahwah, NJ: Lawrence Erlbaum Associates.

Reigeluth, C.M. & Frick, T.W. (1999). Formative research: A methodology for improving design theories. In C.M. Reigeluth, ed., *Instructional-Design Theories and Models: A New Paradigm of Instructional Theories*, Vol. II. Mahwah, NJ: Lawrence Erlbaum Associates.

Reigeluth, C.M. & Joseph, R. (2002). Beyond technology integration: The case for technology transformation. *Educational Technology* 42(4): 9–13.

Simon, H.A. (1969). *The Sciences of the Artificial*. Cambridge: MIT Press.