Comparing Beans and Potatoes, or Creating a Balanced Diet? Different Purposes and Different Approaches

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What are the differences between Learning Sciences and Instructional _____? The previous authors variously used "instructional design," "instructional systems," "instructional systems design," "instructional systems technology," "instructional technology," and "educational technology." But these terms have quite different meanings. Therefore, to answer the question, it is helpful to unpack these terms and concepts.

I define instruction broadly as anything intended to foster human learning and development (Reigeluth, 1999). It differs from learning in that learning is what goes on inside the learner's head, whereas instruction is what goes on outside the learner to foster learning or development. From my personal perspective, it is helpful to think in terms of distinct knowledge bases related to instruction, though they are clearly interrelated, overlapping, and interdependent. These knowledge bases are briefly described next, so we can address the question posed at the beginning of this article.

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Knowledge Bases Related to Learning Sciences and Instructional Sciences

I find it helpful to think in terms of three major knowledge bases: instructional practice, instructional theory, and descriptive theories.

Instructional practice. On the surface, where the rubber meets the road, is instructional practice. There are several kinds of practices related to instruction: design, development, implementation, management, and evaluation (Reigeluth, 1983a). Instructional **design** practice entails selecting methods for a particular situation or case. Instructional **development** practice entails engaging in activities to select or create any resources that will be used in the instruction for a particular situation. Instructional **implementation** practice entails carrying out the instruction that was designed and developed for a particular situation. Sometimes design and development occur simultaneously with implementation, in that a teacher decides what methods to use "on the fly" during instruction and creates resources by writing on a whiteboard. Other times design and development occur at a distant time and place, such as with the creation of Logo as an instructional resource. Instructional **management** practice entails managing the instructional process, resources, and personnel for a particular situation. Much of this may also be done during implementation. Finally, instructional **evaluation** practice entails assessing the quality of some particular instruction for either formative or summative purposes.[1] These different kinds of instructional practice represent a balanced diet of instructional activities. There is a knowledge base about each of these kinds of instructional practice that is primarily comprised of descriptive case studies.

Instructional theory. There is also a knowledge base to directly guide or inform new instructional practice. It is typically called instructional theory but includes models, principles, methods, and so forth, as well as goal-oriented theories. There are knowledge bases to support each of the different kinds of instructional practice. Instructional **design** theory is concerned with what instruction should be like (e.g., whether or not it should include analogies and demonstrations). Instructional **development** theory is concerned with what the process should be like for creating

[1] I do not include analysis theory in this list because it seems to me that analysis is an activity that is required to make decisions related to every one of the other phases of instruction: design, development, implementation, management, and evaluation.

instructional resources and plans (e.g., how to analyze the nature of the content to be taught and the learners). Instructional **implementation** theory is concerned primarily with diffusion, dissemination, adoption, and implementation of instructional programs (e.g., how to help potential adopters to go through the stages of awareness, persuasion, and decision). Instructional **management** theory is concerned with managing an instructional system (e.g., how to manage learners, personnel, and resources). And instructional **evaluation** theory is concerned with conducting formative and summative evaluations (e.g., how to identify weaknesses in the instruction and ways of overcoming those weaknesses). These different kinds of instructional theory represent a balanced diet of knowledge about instruction. They are all design theories[2] or "sciences of the artificial" (Simon, 1969), which identify means for accomplishing goals, rather than descriptive theories or "natural sciences," which describe natural processes or the natural effects of causal events. Furthermore, design theories are built through "decision-oriented inquiry," whereas descriptive theories are built through "conclusion-oriented inquiry" (Cronbach & Suppes, 1969). Since it will be helpful in this article to have a term to refer to the entire range of knowledge bases about instruction, I will use the term "Instructional Sciences."

Descriptive theories. Finally, there are descriptive knowledge bases to support each of these kinds of instructional theory. Instructional design theory is primarily supported or informed by **theories of learning, cognition**, and **motivation**. Instructional development theory is mainly supported by **theories of systems design** and **project management**. And so forth. These in turn tend to be supported by more fundamental descriptive theories. For example, learning theory is informed by **theories of brain physiology**, which are in turn typically informed by still more fundamental theories, such as those of chemistry and biology; and now I've lost the interest of three quarters of the readers, so let's get back to the initial question: What are the differences between the Learning Sciences (LS) and Instructional Sciences (IS)?

Views of Instructional Sciences

The comparisons between LS and IS made in the four articles discussed here are typically incomplete because they have tended to omit important parts of IS from the comparisons. In this sense, they are much like comparing beans and potatoes. Most of the articles compare LS with instructional development theory, with frequent reference to the ADDIE model and the Dick and Carey (1990) text. Barab (this issue) has also included instructional implementation theory in his discussion. But no one includes instructional design theory in their comparisons. This is unfortunate because this is where there is the greatest overlap between the two sciences.

Views of Learning Sciences

Some of the preceding authors characterize LS as only being concerned with descriptive theories, particularly those of learning and cognition. For example, Barab states that "the learning sciences focuses on testing and advancing learning theory ...." In my reading of several learning scientists (e.g., Schank, Collins, Barab, Duffy), I find they are also concerned with advancing instructional design theory, albeit often on a more local level than instructional design theorists outside LS. They are concerned with identifying methods of instruction that work well in particular contexts (situations).

There seems to be some reluctance on the part of some learning scientists to recognize the distinction between learning theory and instructional theory. Yet, as John Dewey (1900) pointed out over a century ago, there is a strong need for a "linking science" between learning theory and educational practice, and the need for such as a science—distinct from learning theory—has been supported by such prominent scholars as Herbert Simon (1969), Jerome Bruner (1966), and Robert Gagné (1977). As Dewey pointed out, the linking science (instructional design theory) is far more useful to practitioners than is learning theory. I believe learning theory is still very important, but that it is much less useful to educational practitioners. Recognition of the instructional design theory dimension of LS would help significantly in comparisons with IS.

General vs. Local Theories

Some instructional design theorists have developed theories that they consider to be broadly applicable or "general," such as Gagné (1977) with his nine events of instruction and Merrill (2002) with his first principles. But it is also true that some learning scientists consider their theories to be broadly applicable as well, such as Schank (1999; Schank, Fano, Jona, & Bell, 1993) with his goal-based scenarios. There are also many instructional theorists who have built instructional theories that are quite narrow or "local," such as theories for the design of computer-based simulations (Alessi, 2000; Gibbons & Rogers, 1991; Reigeluth & Schwartz, 1989; Trollip & Ortony, 1977) for the development of attitudes (Kamradt & Kamradt, 1999), for fostering conceptual understanding (Reigeluth, 1983b), and for drill and practice instruction (Salisbury, 1990).

My view of the general versus local issue is that to be broadly applicable, a method must be general, such

[2]Note that this is a different meaning for design theory than that used earlier, but instructional design theory (in the earlier sense) is a kind of design theory (in this other sense).

as "actively engage the learner in the learning process." The problem is that such general methods provide little guidance for practitioners. As you provide more detailed guidance about how to actively engage learners, that guidance becomes less broadly applicable. There are different ways of actively engaging learners, some of which are likely to be better than the alternatives for some situations (e.g., kinds of learners, kinds of learning, and kinds of learning environments or constraints), while others are likely to be better for other situations. Instructional design theory should identify the alternatives and offer guidance as to the situations under which each is likely preferable. In this manner, instructional design theory can provide detailed guidance while at the same time be broadly applicable. While I support Merrill's belief that there are some universal (or at least broadly applicable) principles of instruction, I also believe that practitioners (especially less experienced ones) need more detailed guidance that is situational. I applaud learning scientists' concern with contextual variables, but I would also like to see their work contribute to a common knowledge base about which methods to use under which situations. As Janet Kolodner, editor of the *Journal of Learning Sciences*, put it in the first issue of that journal, the learning sciences "need[s] concrete guidelines about what kinds of educational environments are effective in what kinds of situations...." (cited by Hoadley, this issue).

Goals of Our Students

Snelbecker (1983) made a distinction between knowledge producers (scholars) and knowledge consumers (practitioners), the latter of which include corporate and government trainers, school technology leaders, school teachers, higher education teaching support personnel, and even designers for museums and zoos. Certainly, even knowledge consumers need to become reflective practitioners (Schön, 1981) who have some understanding of learning theory. Nevertheless, they must devote most of their time to creating instructional plans and products as efficiently as possible, and thus have relatively little time for advancing theory. From the previously noted articles, it seems that faculty in learning sciences are only concerned with preparing their students to become knowledge producers. For example, Duffy (in this issue) states, "for learning scientists the learning environment is a vehicle for testing and building theory while the instructional technologists view the design as an end in itself."

While I agree with Duffy that it is appropriate that "learning sciences tends to approach each new situation as a new design problem" (Duffy, this issue), it makes more sense for IS students who are practitioner-oriented to approach each new situation by looking for appropriate instructional theories to apply. The preparation of knowledge consumers requires IS faculty to teach all the knowledge bases in IS, whereas LS faculty rightly focus on theories of cognition, learning, and instruction. The preparation of knowledge consumers also requires IS faculty to devote some teaching and research to the aspects of instruction ignored by LS faculty: development theory, implementation theory, management theory, and evaluation theory. Practitioners need more of a balanced diet.

In essence, I agree that *some* instructional scientists (those who have a knowledge consumer focus) view the design as an end in itself, for that is the nature of the work they want to pursue. However, some instructional scientists are also concerned with preparing knowledge producers and are concerned with "advancing theoretical and empirical claims" about instruction, especially instructional design theory.

Fields in Transition

Hoadley (this issue) states: "The epistemologies and methodologies of both communities are, interestingly, both in flux." I heartily agree. Learning theory has undergone several paradigm shifts, from behaviorism and humanism to cognitivism and constructivism. Similarly, instructional design theory is undergoing a shift from standardized, teacher-centered instruction to customized, learner-centered instruction. And instructional development theory is undergoing a shift from linearity, rigidity, and designers making all the decisions, to iteration, flexibility, and users sharing in the decision-making (Carr, 1997). When Barab talks about how he "departed from previous instructional design theory and adopted a more participatory model," it may be helpful to keep in mind that many in the instructional development theory area have talked about the need to make fundamental changes in the traditional ADDIE model, with its boxes and arrows, to make it more flexible and participatory (Carr-Chellman, 2000; Ertmer, 2000).

Design Based Research

I applaud LS's development of DBR as a tool to develop theory. I was delighted to see that methodology receive considerable visibility in the recent special issue of *Educational Researcher* (Vol. 32, No. 1, 2003). However, instructional theorists were interested in, and developing, this kind of research before 1992, when Brown (1992) and Collins (1992) published their ground-breaking articles on what was then called design experiments (see, e.g., (Reigeluth, 1989). The "formative research" methodology (Reigeluth & Frick, 1999) is a particular kind of DBR that has been used in more than a dozen studies to develop instructional design theory and instructional

development theory. It offers specific guidance for developing a new design theory and for improving an existing design theory. It also offers different guidance depending on whether the case studied is ongoing or already completed at the time of the research. Hopefully, we will see more of this kind of research in all branches of education, not just LS and IS.

A Balanced Diet?

Several of the previous authors have concluded that LS and IS are interconnected and interdependent. I agree completely. While it is certainly true that the two fields have different terminologies and different orientations, they are both concerned with developing instructional design theory. Based on comments by Barab, Hoadley, and Smith (all in this issue), and the paper by Kirby, Hoadley, and Carr-Chellman (2003), it seems likely that LS's interests may broaden to include other aspects of instruction with which IS deals. Also, instructional design theorists in IS can benefit much from greater awareness of the work that LS researchers are doing. I believe that each field can benefit from work of the other and that, indeed, it makes sense to combine the two fields to create a more balanced diet for each. □

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