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Some Big Questions About Design in Educational Technology

Andrew S. Gibbons
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Abstract

This article asks five questions that lead us to the foundations of design practice. Design processes structure time, space, place, activity, role, goal and resource. For educational technology to advance in its understanding of design practice, it must question whether we have clear conceptions of how abstract conceptions are turned into physical artifacts capable of inspiring the intellect and the emotions to facilitate learning. These five questions hopefully supply topics for design conversations.

Dave Jonassen (2000) said that a good starting point for solving wicked design problems was to clarify the problem. That’s my purpose today. I want to say some things that may help clarify the problem of design and how we teach it.

This isn’t a scholarly presentation. It is more of an essay about instructional design, what it is, how we perceive it, and how we pass our perceptions on to the next generation of designers.

Steve Yanchar and his colleagues recently completed an article for this year’s EMTY about the profession of instructional design (Yanchar et al, in press). Today I won’t be talking about design as a profession as much as I will be talking about design activity as a researchable subject.

I want to pose a series of questions that I hope will have a positive impact on research into how we do instructional design.

**Question 1:** I would ask: Are designers really taught to *understand* what they are doing as they design?

In any design profession—of which there are many—design consists of the structuring of time, space, place, activity, goal, and resource. This is true for architects, auto designers, landscape artists, and designers of learning experiences.

Instructional designers target the creation of both intellectual and emotional
states—not just single states, but sequences of them. For instructional designers the goal of state-sequencing is a condition in the learner of belief, commitment, and capacity that we sometimes refer to as “knowledge”.

It’s easier to think about how design takes place if we step back from the details of any specific position on design and consider design at a more abstract level. Donald Schön (1987) describes the act of designing at this more abstract level in a book significantly subtitled, Toward a New Design for Teaching and Learning in the Professions. He speaks in terms of processes that act upon and interact with structures.

For Schön, the process is a reasoning process, and the structure is a fund of structural concepts that exist in the mind of the designer. Research has shown that for a novice designer the vocabulary of structural concepts is relatively small and tends to pertain to surface phenomena. For expert designers, the vocabulary is larger and richer and deals with deeper, less readily apparent forces.

Schön describes the reasoning process in the following manner (with comments of my own added): “[The designer] spins out a web of moves [or decisions], subjecting each cluster of moves to multiple evaluations drawn from [a] repertoire of design domains” (p. 64). Schön’s “design domains” are where the “conceptual structures” reside. According to Schön, every design draws upon multiple domains, from which it receives structural content. (See Schön, 1987, p. 59, Table 1 for an example of the domains of building design.)

With a tentative set of decisions in mind, Schön says the designer steps back and conducts an evaluation that examines the fitness of the choices: first, in the local context, and then the context of the whole design.

For Schön design is an oscillation between choosing and evaluating, re-choosing, and re-evaluating. As choices are made firm, the designer finds future decisions constrained by former ones, as the designer moves “from a stance of tentative exploration to one of commitment” (p. 64). And I believe the commitments are to structures that have been arranged through the application of some type of process.

This brings me to:

**Question 2:** What structures? And what processes?

Historically, the attention of instructional designers has been focused on a mostly sequential process that has obscured the structures that are created and manipulated by the process: task analysis yields tasks; objectives analysis yields objectives; lesson design yields lessons; test design yields items.

As we step back to more abstract thinking about design, we should consider: What other combinations of process and design structure might define new ways of
thinking about instructional design?

My own views about process and structure are outlined in my recent book, *An Architectural Approach to Instructional Design* (Gibbons, 2014). For me, a key to process is asking the question, “What is the next most important and valuable decision at this moment?” Structure is defined in terms of functionally-related domains, which include content, strategy, message, control, representation, data management, and media-logic. Within each of these domains there exist a wealth of theoretically and pragmatically-defined structural concepts.

But I can’t for a moment believe that the traditional systematic design models and my own views exhaust the fund of ideas about process and structure that could be used to describe design in ways that would enlarge the imagination of designers—both novices and experts.

What other approaches might be used in the conception of new designs? Patrick Parrish (2009) describes how personal and cultural narratives of the designer and the learner can supply structures to be aligned using narrative processes. The goal is to harness the natural energies of the narratives and respect more fully the states active within the learner. Two of our students BYU students, Kristine Manwaring and Chris Faulconer, are exploring this promising approach to design. In addition, Elizabeth Boling’s concept of "precedent", deals with the design language structures of the designer and is an idea that should be given serious consideration (Boling, 2010; Howard et al, 2012).

**Question 3:** Do we teach designers today how to think like designers?

Gagné, Briggs, and many others describe a deductive process for design based on the idea that if you know the type of learning desired, then providing conditions suitable for that type of learning will lead to a desired result. This principle is intuitively attractive, and it is taught in some form in many, if not most, instructional design texts. However, are there other kinds of logic that contribute to design thinking? And if there are, then are we teaching them to students through precept and example?

A strictly deductive process is science-friendly, which agrees with the general opinion that instructional designs should be scientifically sound. However, deduction does not produce the specific kinds of information required to produce a specific design tailored to specific circumstances. The premises of a true deduction are 100% certain (Lipton, 2004), leading to an inevitable conclusion. The premises on which a design is built are never that certain. There are numerous sources of uncertainty in design problems: including, for example, the exact nature of the problem itself. The circumstances of the instructional setting, the environment, and the characteristics of the individual are other variables that can only be dealt with probabilistically.
Josephson and Josephson (1994), referring to the framing of scientific studies, argue that even scientific reasoning requires forms of logic beyond deduction, because the conclusions of a deduction are contained in the premises. They state that "the whole notion of a 'controlled experiment' is covertly based on abduction. What is being 'controlled for' is always an alternative way of explaining the outcome" (p. 21): a "best guess" from among many possible guesses.

Deduction alone cannot produce the new combinations of ideas required for hypothesis making, and designs are all based on untested hypotheses about the future. There may be general principles that suggest that an instructional tactic will work in the general case, but every design is particular to a footprint of time, place, and learner characteristics that are estimated and averaged and therefore uncertain. Charles Sanders Peirce called the necessary sort of reasoning for this purpose “abduction”—a type of reasoning about the future that attempts to pick the best alternative from among multiple possibilities (Buchler, 1955, Chapter 11). Today, Bayesian statistical methods are used to support such reasoning, and this tool is often used in the design of adaptive, intelligent tutoring systems.

The expertise of Josephson and Josephson lies in robotics; they design robot control programs that “learn” the dimensions of a space by encountering obstacles. Though a robot may know in general about the normal proportions of spaces, every space is different in some respects from the norm. A robot cannot predict in advance the dimensions of a particular space. So the program makes a best guess about how to begin exploring the space in which it will operate.

On encountering an obstacle, a robot must decide which way to re-orient and move forward. From encountering multiple obstacles the robot fleshes out the details of the space, but it does not know, nor can it deduce in advance, the dimensions of the particular space.

In this there can be found a strong analogue to making adaptive adjustments during instruction. What a person can learn depends on prerequisite knowledge, but a designer cannot know in advance for a given individual what the individual already knows. If the learning experience is to be adaptive, then some decisions must be made after encountering obstacles, until the dimensions of the learner’s prior knowledge are determined. The case of non-adaptive designs is the same, except a designer must provide for all of the adaptive paths in advance explicitly.

Dorst (2015) argues that design reasoning is a combination of deductive and abductive reasoning, where the degree of uncertainty in the premises requires some degree of guessing or probabilistic inference on the part of the designer. Says Dorst, "deduction and induction are not enough if we want to make something. If we want to create valuable new "things", as in design and the other productive professions, the basic pattern of reasoning is called ‘abduction’" (p. 48, emphasis in the original).

When we teach young designers principles and models for designing, we are at the
same time implying to them how designers think and reason. Design theorists in the field of instructional design should examine more closely the broad range of reasoning processes of the designer and devise ways that teach not only deductive methods, but inductive and abductive methods as well: thinking that can lead to designs outside the box.

Question 4: Design moves from abstract structures to concrete ones. How does one do that? Are there perhaps logical progressions of aligned structures?

Years ago, when I knew only systematic model processes for design I envisioned a product I called the ISD database. At the time I was involved in aviation training, and traceability from objectives to elements of instruction was essential. The idea of the ISD database was to link abstract goal structures to less abstract, evolving structures in a logical way to permit tracing the instructional goal to the training events that in some way supported it.

It was possible to trace the evolution of goal structures into instructional event structures using a kind of mapping process. But while working out these relationships, Vic Bunderson, Greg Kearsley, Jim Olson, and I discovered a gap in the logical linkages, which we filled with an intermediary construct that we called the "work model" (Bunderson et al, 1981; Gibbons et al, 1995).

The point I want to make is not about the work model or about systematic design models. Rather, it’s about how any designer might trace, using a path or map or any other means, the reasoning that leads from the completely abstract beginning point of a design through to completely concrete media resources, and then on through to completely abstract emotional and intellectual experiences that lead to learning.

Are we able to describe to new designers how this works? Are we able to give an account of how resources set in motion invisible emotional and intellectual forces that increase the likelihood of learning experiences? Or are we left like the befuddled scientists, writing on the blackboard, "...and then a miracle happens?"

The answer to this question need not lead to determinism or reductionism. But we need to be better able to explain how specific designs achieve their effects. Imagine a building designer who was not able to explain why a building stood up to wind.

If designers are to become more aware of their own reasoning processes so that they can talk and write about them publicly, then they must also develop some sense of the intermediary structures that do not represent concrete media objects or the abstract learning experience, but that represent important intermediate design structures that are steps in the evolution toward those things. The conceptual structures of the designer are an important basis for this kind of reasoning. It is these structures acted upon by process that constitute a designer's competence.
Question 5: One might ask: "Haven't we already flirted enough in the instructional design field with structural concepts? Shouldn't we be thinking in less structural terms, rather than more?" To answer that question I would like to appeal to the history of the computer display and how it works on our visual system.

Most people can recall a time when there were 300 X 200 squares on a computer display, with two sets of four colors to choose from. We were so excited to us to get 640 space X space 480. Over time, the resolution of screens and the number of colors increased, but in those early days it was easy to see individual pixels and sprites that made up display elements.

Today we have photorealistic displays where individual picture elements are not visible, and each one can take on any one of millions of colors. In the past we have dealt with the elements of instructional designs at the low level of resolutions typical of the early computer displays. We speak of elements of the learning experience as if they were discreet and identifiable: "review"; "objective"; "practice". However, it is possible for us to describe the elements of our designs at a higher level of resolution such that the experience of the elements does not detract attention from the feeling produced by the elements en suite.

It is possible that the individual elements of our designs could blend so that the learner was no more aware of their individuality than we are today aware of individual pixels on a display screen?

Conclusion

The questions in this essay are rocks that I believe instructional design theorists and practitioners are at this point in time willing to turn over, to see what lies beneath. New departures in design studies in recent years represent a healthy trend. We are becoming more aware of and curious about the foundation principles of our practice and our emerging design professionalism.

We need to talk more within our organization about new directions in design, asking questions that lead to possible futures of how we teach design to students...and to the vast army of instructional designers whose needs we do not now adequately address.

There are important new ideas to be found in the work of Gordon Rowland, Elizabeth Boling, Brad Hokanson, M. J. Bishop, Patrick Parrish, and several others whom I hope this audience will seek out. Some day designers will take these new ideas as much for granted as we have taken the ideas of the past for granted and find a new vantage point for looking to the next horizon.

References


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Dr. Andrew S. Gibbons is a faculty member in the Instructional Psychology and Technology Department of the McKay School of Education at Brigham Young University. His current research focuses on the architecture of instructional designs. His book, *An Architectural Approach to Instructional Design* (Routledge, 2014), expresses a theory of instructional design layers, design languages, and modularity.
Gibbons has published a domain theory of Model-Centered Instruction, and is currently studying the use of layers, languages, and modularity as tools.