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Science vs Art in the History of Learning, Design, and Technology

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Psychological theories and design models can inform and guide the design decisions of instructional designers. As suggested by Merrill (1996), Learning, Design, and Technology (LDT) is "using scientific principles to invent instructional design procedures and tools" (p.5).

On the other hand, the crafting nature of LDT also requires recognizing the creativity of LDT designers. Heinich (1984) suggested that an applied science such as LDT should not "hesitate to use methods and materials that work even though explanations as to why they work aren't available" (p.83). These two different views of LDT reside in the different understanding of whether design and research should be a scientific inquiry or an artistic creative process. This paper aims to consider these two different views from LDT history by reviewing representative research and designs from three eras: behaviorism, cognitivism, and constructivism.

The Behaviorism Era - Theory Driven vs Subjectivity Driven

The scientific tradition began to have a deep influence on the LDT field during the first half of the twentieth century, when behaviorism became the dominant philosophy of education (Smith and Ragan 2005). Most behaviorists endorse the principle of positivism, which claims that researchers know this world only through objective measurement, and learning theory should be developed under rigid scientific experimentation (Winn and Snyder 1996). Influenced by this belief, most of the early work in LDT followed this methodological behaviorist tradition and neglected researchers' personal experience, introspection, and subjective observation (Burton et al. 1996; Kendler 1961). Skinner is the representative of such belief. Most of his studies were guided by psychological theories and conducted under an environment in which variables are strictly controlled. Also, his instructional design product—the programmed learning machines—was developed to provide students with the correct scientific learning path through behavior reinforcement (Skinner 1958). His research and instructional design style reflect his understanding of LDT research as finding generalizable behavior laws and using them as formulas to design instruction that leads to the expected behavioral responses.

On the other hand, by the early 1960s, a few behaviorists began to value their subjectivity as researchers and departed from radical behaviorism. Crowder's (1959) intrinsic programming learning and Keller's (1968) Personal System Instruction (also called Keller's plan) are two classic examples. From a methodological perspective, unlike radical behaviorism, which excludes researchers' subjectivity, both Crowder's and Keller's work were derived from their personal experiences in teaching and learning and were not necessarily based upon a learning theory (Klaus 1965). They realized that overreliance on machines might lead to dehumanization and the neglect of students' interactions and other social variables (Fitzgerald 1962; Keller 1968). Their unique instructional solutions deviated from a mechanical control over students' behavior and provided students with more autonomy in the learning process.

The Cognitivism Era – Universal Laws vs Dynamic Model

By the early 1980s, the development of personal computers inspired educational scholars to view the process of learning as similar to a computer system, with emphasis on the learner's memory, perception, and information processing (Bishop 2014; Driscoll 2005). Influenced by cognitivism, many LDT researchers and designers focused on developing and testing strategies to facilitate mental information processing. Although their focus shifted from students' behavior to thinking, similar to behaviorists, who were dedicated to

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finding generalizable behavior learning laws, most cognitivists focused on discovering the most efficient ways of mapping external information onto learners' minds (Jonassen 1991). These cognitivists held the assumption that instructional designers should strictly follow those laws or prescriptions when designing and organizing learning information.

On the other hand, instead of finding universal laws, some cognitivists in LDT adopted new perspectives toward the role of scientific laws and models. They focused on the transferability of those laws and models to the local context and less on their generalizability. Specifically, many LDT researchers focused on developing process-oriented models that view instructional design as a collective social process that calls for collaboration between ID researchers and practitioners (Willis 2009). For instance, based on expectancy-value theory, Keller (1987) proposed the Attention, Relevance, Confidence, and Satisfaction (ARCS) model as a framework for improving the motivational appeal of instructional information design. Although the model included sample instructional strategies, it was not designed to provide instructional prescriptions for instructors. Instead, the model functioned as a systematic guideline that helps instructors analyze the specific situations they deal with (Keller 1987). Keller viewed ID models not as universal laws but as guiding design principles that help practitioners make decisions in local contexts.

The Constructivism Era – The Combination of Science and Art

In the early 1990s, situated learning and apprenticeships suggested that learning should happen in its original context, which is in opposition to the view that learning is about the acquisition of decontextualized and generable scientific facts and laws (Brown et al. 1989; Suchman 1987). The philosophy behind this is constructivism, which regards learning as a dynamic process in which students construct their own understanding based on their experiences (Winn 1993). Although a more organismic view of the learner was adopted, constructivists still have different views regarding the nature of knowledge and how much freedom should be given to students, which lead to different perspectives in LDT. For instance, radical constructivism, also known as personal constructivism, posits that learning is an entirely individual constructing process through personal experience without reflecting the external world (Von Glasersfeld 1996). This belief leads to a completely bottom-up instructional design approach by minimizing teachers' interventions and maximizing the autonomy of students. However, many moderate constructivists in LDT found that the extreme learning environment might be too ill-structured and too open (Karagiorgi and Symeou 2005). As Jonassen (1994) suggested, although the prescriptive theory of instruction does not fit constructivism, explicit guidelines on how to design learning environments are still needed.

Although belief in constructivism varied among researchers, more researchers in LDT began to shift their focus from the design of instruction to the design of an environment that brings about a meaningful experience to the learner (Boling and Smith 2018; Parrish 2009; Wilson 2005). Examples include the use of simulations and games to create a learning environment which supports personal discovery and exploration, such as River City (Dede et al. 2004), and Quest Atlantis (Barab et al. 2010). Parrish (2009) suggested that creating these learning environments requires the imagination and empathy of the instructional designer. On the other hand, those who created these meaningful environments also emphasized the use of design principles, empirical guidelines, and models in making better design decisions. Accordingly, a methodology that emphasizes designer's subjectivity and scientific models began to emerge in LDT, known as design-based research (DBR). DBR not only aims to solve educational problems through design and development with a respect for researchers' imaginations but also empathizes generating design principles and local instructional theory.

Summary

Since LDT is not only an inquiry science but also an applied science, the subjectivity of researchers cannot be ignored as their teaching experiences, design heuristics, and empathy toward students enable them to discover the gaps that will bring about innovative improvement. On the other hand, science ensures the reliability and validity of the research and design. A product or research that is both scientific and creative is always desirable.

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