Design Thinking: A New Construct for Educators

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Abstract

Design Thinking is a creative problem-solving approach being considered for use in teacher education and research. However, since the term “design” has been over-used, some might question whether Design Thinking is more than an old idea with a trendy new name. In many cases it is still unclear as to what the theoretical basis for Design Thinking is, whether it aligns well with the field of education, or how it compares to other well-established approaches. We will show that this fuzziness stems from three Design Thinking discourses which overlap, but do not always align. We will describe Design Thinking and how it compares to Inquiry-Based and Problem-Based Learning, Instructional Design, and Design-Based Research. Finally, we will describe a pilot study utilizing a Design Thinking approach. This material is based upon work partially supported by the Engineering Research Center Program of the National Science Foundation under NSF Cooperative Agreement No. EEC-1449501. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect those of the National Science Foundation.

Design Thinking Background

Both Kimbell (2011) and Johansson-Sköldberg, Woodilla, and Çetinkaya (2013) agree that Design Thinking is one of separate discourses. Both suggested that there is a scholarly discourse founded on theoretical and empirical research, and a business innovation discourse founded on experiential and anecdotal evidence. Kimbell further suggested a third discourse embedded in the wicked problems discourse first argued by Rittel and Webber (1973). These authors caution researchers to be cognizant of the appropriate theoretical foundations for proposed studies into Design Thinking.

Scholarly designerly thinking discourse. In 1969, Herbert Simon wrote a chapter on the “Science of Design” in a book entitled The Science of the Artificial in which he argued for a need to better understand the process by which manmade objects were produced. While his book suggested a post-positivist stance (Buchanan, 1992), Simon was one of the first to suggest that professional designers solve problems differently than professionals in other fields (Johansson-Sköldberg et al., 2013; Kimbell, 2011). In juxtaposition, Donald Schön’s (1983) work, The Reflective Practitioner, reflected a more constructivist stance, and suggested that the design process was one of divergent-convergent conversations with the problem frame in which the designer dually reflects-on-action and reflects-in-action.

Throughout the 1980s, Lawson, Cross, and Rowe separately conducted empirical research utilizing ethnographic and case study methods to better understand and define designerly knowledge and the process by which they solve problems (Johansson-Sköldberg et al., 2013). Through the work of these researchers, it was determined that designerly thinking is an approach to solving design problems utilizing an abductive process. They described this approach as inherently ambiguous, iterative, productive, visualized, collaborative, empathetic, situative, and satisficed. Further, while Designerly Thinking is systematic in its process, with designers often utilizing process models from within their own fields, designers diverge and converge from these models as part of their attempt to better adapt their understanding of the problem frame based on new and changing information. By
the 21st century, continued research in the field led Cross (2011) to the suggestion that designerly ways of knowing could be utilized within any field as a more general Design Thinking approach.

**Wicked problems design thinking discourse.** Johansson-Sköldberg et al. (2013) considered the wicked problems Design Thinking discourse to be a refinement of the Scholarly Designerly Thinking discourse since it still relies on the same theoretical foundations. However, Kimbell (2011) argued that the addition of Rittel and Webber’s (1973) Wicked Problems approach changed aspects of the original conversation, which warranted its own discourse. This offshoot occurred when Buchanan (1992) suggested that the Design Thinking discourse was becoming too scientific. He suggested that while researchers should scientifically study the design process, the design process itself should not be likened to a scientific process as originally suggested by Simon (1969).

Rittel and Webber (1973) argued that solutions for “wicked” problems must be determined within context because a systematic formula for solving them does not exist. Because the designer satisfices the solution by determining the stopping point for the solution when it is good enough, wicked problems are technically without final solutions. While wicked problems may seem similar to other known problems, there will always be some aspect that is unique. Therefore, designers must be careful about selecting an obvious solution too early in the process. Also, one determined wicked problem may simply be the symptom of a greater wicked problem.

Buchanan (1992) utilized learning theory from John Dewey (1986) combined with these wicked problem characteristics to describe a Design Thinking process as a balance between the analytic and creative.

**Innovative design thinking discourse.** The Innovative Design Thinking discourse seems to have originated in the early 1990s when Stanford University mechanical engineering professor David M. Kelley participated in a merger of several design firms which led to the creation of the design consulting firm IDEO (Johansson-Sköldberg et al., 2013; Kimbell, 2011). Kelley continued to work for Stanford and be part of IDEO. While at Stanford, he taught design education courses utilizing design process strategies. In 2005, he partnered with the Hasso Plattner Institute in Potsdam, Germany, to create the Stanford University Hasso Plattner Design School, nicknamed the d.School (d.School, 2016). As part of this program, students from any degree field may take courses on problem solving utilizing the Stanford model within a design studio environment. Concurrently, Roger Martin (2009), Dean of the Rotman School of Management for the University of Toronto and former consultant for IDEO, and Tim Brown (2009) current CEO and president of IDEO, made an argument that the Design Thinking approach can be applied within almost any field to develop innovative solutions. Most recently IDEO, in conjunction with a school district, created a *Design Thinking for Educators* toolkit based on the IDEO Design Thinking process model (IDEO, 2016).

Much of the literature from this discourse supporting the IDEO and Stanford models was based on the personal experiences or anecdotal evidence of these designers. This does not suggest that their models lack impact or efficacy; it simply means they were not empirically-based. Yet the Stanford and IDEO models are quickly becoming the basis for empirical studies beyond the field of business, such as healthcare and education. This may be due to the strongly parsimonious nature of their models. However, the Scholarly Designerly Thinking researchers would argue that Design Thinking cannot be diluted down to a linear process model as this would defeat its base assumptions (Cross, 2001, 2011; Lawson, 2006; Rowe, 1991). With this in mind, it is a combination of the Scholarly Designerly Thinking and Wicked Problems Design Thinking discourses, both of which are theoretically-and empirically-based, that will form the basis for this discussion.

**Design Thinking Approach**

Though Design Thinking researchers agreed that certain assumptions define the Design Thinking approach—such as ambiguity, iteration, production, visualization, collaboration, empathy, situation, and satisficing—the abductive, non-linear nature of the process does not suggest a simple process model (Cross, 2006; Buchanan, 1992; Rittel & Webber, 1973). Design Thinking’s fuzziness of construct might suggest a whimsical nature in which only those attuned to some magical internal force can use it successfully. Yet, research demonstrated that while it involves creativity of thought and a willingness to accept uncertainty, Design Thinking is most often conducted in an extremely systematic way (Cross, 2001, 2006; Lawson, 2006; Rowe, 1991).

Designers may have been taught a traditional linear process model for their specific design field; however, in practice they often did not follow these models step-by-discrete-step. Instead, they purposefully used a recursive process to diverge from one step to return to an earlier one, often picking up new information in the process. This problem-framing process caused the designer to simultaneously understand the initial problem while searching for a solution (Cross, 2006; Lawson, 2006; Schön, 1983). This caused designers to change and reconstruct their frame over and over again. It is likely that they begin by developing many mini solutions—which diverged from the traditional process to follow certain aspects of those solution paths—and tested them by building or sketching.
models until the rationale they followed collapsed and led them to converge again. Eventually this fluctuating divergence-convergence of problem-solution paths narrows and slows, until through a situation of satisficing, the designers decide they have a workable solution for that situation in that moment. Please note that this process is not geared to finding THE BEST possible solution; instead, it searches until it finds a workable one. However, it is possible that the workable solution is the best possible solution.

As part of this process, most designers clarify the problem, seek empathy through multiple stakeholder perspectives, develop ideas through prototypes, and then test those prototypes (Cross, 1990; Kimbell, 2011). They also reflect and revise throughout (Schön, 1983). However, note that Design Thinking researchers have refrained from developing their own Design Thinking process model perhaps fearing that such a model would imply sequential, discrete stages to be followed in a rigid way, which would defeat its very assumptions (Buchanan, 1992). At the same time, Cross (2006) strongly conveyed the importance of sketching and visualization as a method for increased insight when working with wicked problems. With that in mind, Figure 1 demonstrates the asymmetrical fluctuating nature of the process.

Design Thinking Comparison

Design Thinking encompasses the base assumptions and processes utilized by professional designers across design fields. However, each field has developed its own process models, patterns, and assumptions specific to their individual fields. Some design fields, such as graphic, interior, or fashion design more heavily relate to a creative craft in which intuition plays a larger role. Other more technical fields are built on a stronger foundation of systematic analysis, such as engineering, architecture, or instructional design. This does not mean that creative design fields are not systematic or are without rules, nor does it mean that analytical design fields ignore context, innovation, or aesthetics. Therefore, while Instructional Design has its own models and processes, it has Design Thinking as a core set of principles and practices in common with other design fields such as graphic design or architecture. Also, researchers have begun to build upon the notion of teachers as designers, and to suggest that teachers need to develop design dispositions (Kali, McKenney, & Sagy, 2015; Koh, Chai, Hong, & Tsai, 2015; McKenney, Kali, Markauskaite, & Voogt, 2015; Svihla, Reeve, Sagy, & Kali, 2015) that will help them adapt to the complexity of teaching in the 21st century (Darling-Hammond, 2006; Jordan, 2016). However, there are already several well-known problem-solving approaches utilized in teaching.

Figure 1. Visualization of the Design Thinking Approach.
Problem-Solving Approaches

How is Design Thinking different from Inquiry-Based Learning, Problem-Based Learning, Instructional Design, or Design-Based Research? To answer this question, we chose to compare their base epistemologies, agents, definitions, roles of the teacher, and assumptions (see Table 1).

**Agents.** For the purpose of this presentation, we define the agent as the person primarily in charge of moving the learning approach forward. Without this person, the approach would fall apart. Inquiry-Based Learning and Problem-Based Learning have the learner as the main agent. The designer is the main agent for Instructional Design and Design Thinking, and the researcher is the agent for Design-Based Research. While it is possible that teachers could choose to utilize Design Thinking as a K-12 learning strategy, it is meant to be used with highly ill-structured wicked problems and assumes a certain level of base knowledge. Design Thinking would be better used by teachers as designers to create learning experiences for students. In contrast, Inquiry-Based and Problem-Based Learning are instructional strategies through which learners come to their own understanding of the content with guidance from the teacher through scaffolding, modeling, and coaching. Instructional Design is most often enacted by a professional who has a degree in an Instructional Systems Design field. While teachers may be taught some Instructional Design methods, they do not have the same level of expertise that the professional designer does and may find the detailed lesson plans expected within the field to be impractical for their own use in the classroom. In Design-Based Research an outside researcher works with a classroom teacher to develop, test, and revise a learning intervention.

**Epistemologies.** Two major aspects of educational reform have changed how lesson planning is perceived. First, the No Child Left Behind Act moved schools towards a more standards-based focus, which resulted in high-stakes testing and data-driven curricula (Dee & Jacob, 2011). Second, educational reforms, such as Common Core, 21st Century Skills, and Next Generation Science Standards have resulted in a drive towards critical thinking and inquiry as equally important as specific content areas (Core Standards, 2016; NASBE, 2016; P21, 2016). These have given rise to constructivism and the learning sciences field (Drsicoll, 2007; Jonassen, Cernusca, & Ionas, 2007; Reiser, 2007).

All five problem-solving approaches utilize some aspect of a constructivist perspective; however, they differ in the degree to which the environment provides learning structure and accountability on the part of the agent for developing successful solutions. Both Inquiry-Based Learning and Instructional Design continue to lean towards a post-positivist science stance, even though they have constructivist leanings. Some Instructional Designers may argue that constructivism is antithetical to behaviorist and information processing cognitivist-based Instructional Design (Reiser, 2007), but Instructional Design has experienced a shift making it more about what works best for those learners at that time, which is a pragmatism that can work with aspects of constructivism (Smith & Ragan, 1999). Proponents of Inquiry-Based Learning describe it as emerging from a constructivist stance in which students explore scientific problems; however, they also heavily rely on a linear 5E stage model and conduct research on how best to train teachers to its correct use in the classroom (Lakin & Wallace, 2015). This suggests that Inquiry-Based Learning promotes higher level critical thinking and engages and motivates students through a personal connection with the problems, while still heavily promoting right and wrong answers, which is a more post-positivist stance.

Problem-Based Learning, Design Thinking, and Design-Based Research heavily focus on context and experiential participation; yet, they still assume a systematic process. This suggests that they are moderately constructivist with pragmatist leanings. Some have argued that Problem-Based Learning is too open and lacking in structure to be an effective learning approach (Kirschner, Sweller, & Clark, 2006); however, proponents of Problem-Based Learning argue that, as an approach, it involves heavy scaffolding and has been shown to be empirically effective (Hmelo-Silver, Duncan, & Chinn, 2007). Design Thinking utilizes an abductive fluctuating approach to problem framing and solving, often combined with the use of a field specific process model. This approach is both creative and analytical, and designers are expected to determine when they have reached the most workable solution. Not the correct solution, but the best one at that time given the information they have and the needs of the users. This implies a pragmatism. Design-Based Research is a research method promoted by learning scientists who believe “learning, cognition, knowing, and context are irreducibly co-constituted and cannot be treated as isolated entities or processes” (Barab & Squire, 2004, p. 1). They are constructivists in that the research must be situated in context; however, they would accept both quantitative and qualitative data as meaningful evidence. This also suggests a pragmatist stance, making it pair well with Design Thinking.

**Definitions.** Part of the reason that it is necessary to compare these approaches is the similarity of their definitions. All five approaches define themselves as a way to construct learning as part of participating in problem-solving. Even Design-Based Research develops, implements, and tests learning interventions. However, it is supposed that most research, including Design-Based Research, has at its base an educational learning question and,
therefore, a problem. Also, the nature of Design-Based Research questions focus on how and why, rather than on what, which suggests that these problems are somewhat ill-defined. But problem-solving is not an explicit assumption of Design-Based Research. The other four approaches describe the type of problem best utilized with their approach.

For example, Inquiry-Based Learning is often paired with science, technology, engineering, and math (STEM) subjects, with a heavy leaning toward science. This approach often uses the 5E model of engage, explore, explain, elaborate, and evaluate (Lakin & Wallace, 2015). Because of the linear aspect of the model, and an assumption that solutions must be supported and rationalized through evidence, this approach works best with structured problems.

Instructional Designers are taught to conduct needs assessments to determine whether or not instruction is even warranted. However, because of the extremely systematic process they are expected to follow—and the fact that most Instructional Design is created for industry which often provides relatively structured parameters—this approach works best with somewhat to moderately ill-structured problems.
Both Problem-Based Learning and Design Thinking work best with problems that have a highly ill-structured nature. However, Jonassen and Hung (2008) suggest that design problems may simply be too abstract and complex for a learner to work through with any level of autonomy. While Problem-Based Learning problems are extremely ill-structured, Design Thinking problems are wickedly so. Therefore, Design Thinking is best used with students who have some content expertise already.
Roles of the Teacher. The role of the teacher in each of these approaches is quite distinct. In both of the strategy approaches, Inquiry-Based and Problem-Based Learning, the teacher acts as a guide or facilitator. In Inquiry-Based Learning, aspects of the learning can be labeled correct or incorrect. This suggests that the teacher needs to closely monitor learner understanding and application. In Problem-Based Learning, the learning is more learner directed. This requires teachers to ensure that learners have opportunities to gain the knowledge they will need to create an effective solution. With Instructional Design, the teacher acts as the subject matter expert (SME), offering information on the constraints, learning goals, objectives, and issues of style. With Design-Based Research, the teacher is a little bit closer to the research than with Instructional Design. Without the teacher, the researcher would be shut out of the classroom, so they are co-creating. However, the researcher usually has slightly higher authority on how the research will be planned and conducted. Lastly, with Design Thinking, the teacher is the designer. He/she has the expertise, the knowledge of the classroom, the knowledge of the subject, and is responsible for constructing the learning environment. He/she is also aware of any possible constraints. To be the most effective though, the Design Thinker will heavily utilize interviews, surveys, and observations of all stakeholders in order to make the most informed decision they can. This means teachers do not simply assume an understanding of their learners, they actually work with them for better empathy and insight.

Assumptions. Since all five approaches utilize a constructivist stance on some level, many of their assumptions overlap. For example, all five approaches suggest some aspect of communication. Inquiry-Based Learning promotes question asking, Problem-Based Learning requires multiple perspectives, Instructional Design requires a task analysis which involves working with various stakeholders, Design Thinking is empathetic, and Design-Based Researchers work with the teacher. Closely connected to this is the concept of collaboration. Problem-Based Learning and Design Thinking explicitly assume collaboration while it is simply implied in the other three. All five must develop, implement, and test something, whether that be a hypothesis, curriculum, or intervention. All five also suggest some type of revision, reflection, or evaluation. Yet there are still a few points of difference. Problem-Based Learning is more self-directed than Inquiry-Based Learning. Problem-Based Learning, Design Thinking, and Design-Based Research stress the importance of authentic, situated learning problems. Design Thinking sees the power of ambiguity and failure as a learning path, and as such, is extremely iterative while also suggesting that the designer satisfies the solution at some point. Lastly, Design Thinking assumes that the best designs are ones that have been visualized through story-boards, concept maps, sketching, and proto-typing or, in education, mini-teaches. This does not imply that the other approaches are against visualization or iteration—these may even be implied—but they are not a focus the way they are in Design Thinking.

Design Thinking Pilot Study

The 21st-century learning environment has changed what teachers must know and be able to do. Today’s teachers face complex and ambiguous issues that can best be defined as wicked problems that require a shift in thinking (Jordan, Kleinsasser, & Roe, 2014). As a way to tackle the uncertainties inherent in education, other scholars assert that 21st-century teachers need to become designers who consider not just the lesson itself, but also aspects of the setting, stakeholders, and resources (Darling-Hammond, 2006; Kirschner, 2015; Lambert & Gong, 2010; Svihla et al., 2015) to create a specialized learning experience every time they teach (Laurillard, 2012). Researchers argue that teacher education programs must begin to incorporate Design Thinking, a creative problem-solving process, into their coursework (Kali et al., 2015). As a first step, however, we must first determine how Design Thinking practices influence education. A Design Thinking educational approach could increase experienced teachers’ dispositions towards design by providing a framework for developing higher-level inquiry and innovation for their students’ learning experiences (Koh et al., 2015) while continuing to align that instruction with current best practices in teaching. However, educational research on Design Thinking is still in its infancy. We are therefore interested in exploring the following questions:

1. How do Design Thinking practices influence STEM teachers’ lesson designs?
2. In what ways do STEM teachers believe Design Thinking aligns with the design of learning experiences?
3. How and to what extent do STEM teachers believe Design Thinking practices could be effective in pre-service teacher preparation?

Method

We utilized a Design-Based Research (Brown, 1992) method in which we worked directly with the teacher participants to develop the curriculum intervention that would be utilized in their classrooms. For this study, we
preferred to focus on in-service teachers who demonstrated expertise in their content area based on the fact that they have chosen to participate in a summer program called a Research Experience for Teachers (RET) through Engineering Research Centers (ERC) housed at a large southwestern university. The ERCs worked with local partner schools to invite teachers to apply for the 5-week RET program. Eight teachers were selected to participate in two separate ERC programs, one in biogeotechnics and one in solar power. Of the 16 teachers, one teacher took on more of an administrative role and was not there for all of the events, limiting the study to 15. Five teachers were male; ten were female. Nine teachers represented underrepresented populations and six were white. Thirteen of the teachers were over 30. Fourteen teachers have taught in K-14 education for at least four years, with ten having taught at least seven years. Grade levels were pretty evenly split with four teachers teaching elementary, four teaching middle, four teaching high school, and three teaching community college. Ten teachers have Masters degrees in some education field and two have doctorates.

Procedure

**Phase I.** During the first week of a five-week summer program, the first author conducted a three-hour Design Thinking workshop for two separate groups: RET A (biogeotechnics) and RET B (solar energy). Before participating in the workshop, RET A and RET B teachers took the Pre-Design Thinking Survey, which included a design disposition scale by Koh et al. (2014). For RET A teachers, the Design Thinking overview session included RET teachers and undergraduate and high school students. Because this group included people other than teachers, the workshop provided a general overview of Design Thinking, and everyone participated in a design activity in which they worked in teams to design the ideal science lab. While the workshop was conducted for the whole group, data was only collected on the teachers. For RET B teachers, the workshop was split across two days and only included teachers. Their workshop more specifically discussed Design Thinking as an approach for designing learning experiences. The design activity more directly had participants begin to brainstorm actual curricula.

**Phase II.** Over the next four weeks, the first author worked with both RETs to facilitate their creation of a curriculum project based on their summer lab experience. During the first session in week two for RET A, she conducted a semi-structured Opening Discussion Group Interview about teacher participants' common lesson design practices before we heavily utilized the Design Thinking model. Then, once a week, she formally met with just the RET A and B teachers. During this time, she worked with them on the next stage of the Design Thinking approach. They then worked on that stage of the model to help them create their curriculum module. For example, during Week 2, we brainstormed their problem based on the lab to which they had been assigned; during Week 3, we worked on determining solution ideas and sketched those out; and during Week 4, they tested and gave feedback for their solutions. In RET A, we had teacher participants describe their lesson to the undergraduate and high school students and elicit feedback. Then, though RET A and RET B teachers had never met before and worked in slightly different science fields, we had them formally meet to present their lessons to each other and gain feedback. At the end of the final week, she conducted a Post-Design Thinking Survey.

**Phase III.** As teacher participants finalize their lesson designs, the ERCs have asked that they implement them in their classrooms. We are working with the teachers to observe and take field notes of those lessons.

Conclusion

The Design Thinking approach is a general process for solving wicked problems with first principles stemming from all design fields. As such, it can be partnered with more specific design models such as ADDIE/ASSURE to help walk novices through initial processes or it can be applied alone to generate more abstract critical inquiry. Because of the extremely ill-structured nature of Design Thinking problems, it is recommended that Inquiry-Based or Problem-Based Learning be enacted with learners while Design Thinking be utilized for lesson design with teachers, making it more similar to Instructional Design. However, while the use of Instructional Design for teacher lesson designing has proven useful, it has never proliferated in K-12 public education. It has been suggested that, since teachers do not have to demonstrate explicit lesson writing ability in real-world practice and since instructional design can be extremely time consuming in its implementation, teachers simply find it impractical. While a Design Thinking approach is not conceptually simpler or easier to learn, it is relatively flexible in its application and does not require the same level of fine detail or adherence to rules/steps as instructional design. Design Thinking does promote sketching, modeling, and prototyping—which could be represented in teaching as outlining, storyboarding, role-playing, or mini-teaches—but Design Thinking proponents would not expect every aspect of the process to be explicitly delineated as long as a final working learning experience resulted. The drawback is that expert designers apply design patterns they have created as a result of their prior design.
experiences while constructing the problem frame. Novices do not have a large store of these design patterns with which to reconceive the same problem frame. Thus, while it is important to allow pre-service and novice teachers opportunities for uncertainty and failure, it is equally important that they are provided with basic strategies and patterns that they can then apply to real-world situations.

Design Thinking is not a free-for-all. It simply assumes a balance between the analytical and the creative, and not allowing one to subsume the other. Teachers can absolutely utilize instructional design models. But if they spend all of their time methodically following each step, without truly understanding the connection of those steps to the overall learning and the individual needs of their students, they will have missed the whole point of the instruction. Design Thinking provides a method for teachers to step back and view the whole picture.

References


