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Innovating Education Through Design Thinking: A Case Study of Problem-Solving Educators

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Innovating Education Through Design Thinking:

A Case Study of Problem-Solving Educators

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Dedication

I dedicate this dissertation to my family. To my mother, for being the quintessential expression of a life-changing teacher and defender of children's well-being for nearly 40 years, and counting. To my father, for providing the ineffable education on how to be a man. To my wife for holding the holy mess of our life in her arms, and bringing our two children into the world. To my daughter, for showing me what it means to love as a father. And to my son, for showing me that love grows.

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Abstract

This study aimed to identify methodologies and practices that enable innovation to thrive in the public education system. Design thinking (DT) was selected for examination given its demonstrated ability to: (a) make people and teams more innovative , (b) change institutional cultures to be more creative and solution-oriented, and (c) create conditions necessary for innovation to thrive within established organizational structures. This intrinsic case study explored the experiences of a group of education leaders who used design thinking to innovate solutions to the intractable problems they faced. Participants in this study were teachers and administrators who received training in DT, and functioned in roles where DT is required as part of their professional practice. The data for this study included field observations, interviews, and documents, which were qualified using two cycle coding. In the first cycle, *a priori* codes were aligned to the Eight Design Abilities of Creative Problem Solvers, followed by a second round of *in vivo* coding that allowed natural themes to emerge. The analysis of results indicated that the use of DT: (1) created conditions whereby educators embodied the skillsets and mindsets of *designers*, (2) enabled educators to self-actualize their creative confidence, and (3) fostered universal collaboration.

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Preamble

The Dream

I attended Rowland Elementary Laboratory School, a public school nestled on the rural campus of Shippensburg University that operated in partnership with the College of Education. This entrance into schooling left me with the wonderfully naïve assumption that teaching was about finding new, exciting, and student-tailored methods to learn. Teachers modeled how to innovate by sharing with students that lessons were prototypes, and students were collaborators in the refinement process. The school was originally established as part of a network of university-run public schools aligned to the work of John Dewey and Progressive Education. The function of the school, as the term "laboratory" implies, was to be a place where instructional innovation could be developed and piloted. Successful ideas were further refined and then recommended for wider practice across the progressive educational landscape. The teachers were baby boomers influenced by the cultural revolution of the late 1960's and that ethos seeped into their principles, political beliefs, and personal commitment to a liberal utopian future. As such, the ideas of Dewey were fully embraced as gospel and implemented with integrity. The school entranced children into an almost dream-like experience where love, respect, kindness, exploration, and learning occurred seamlessly and simultaneously.

Innovation's preeminence was apparent throughout the school. Grade levels would be gathered together to foster opportunities for collaboration. Older students taught lessons to younger students, multi-grade teams would go on scavenger hunts, interest-based groups would go on field trips, and units of study would often begin with a visit to a college professor's classroom for an introductory lesson. They created a program of hands-on, project-based learning, decades before this term was coined. For example, we built nets with one of the zoology professors and spent a late spring evening catching, tagging and releasing the

bats. Students who lived on dairy farms brought milk that we used to make butter and cheese. We cooked turkey together for those in need at Thanksgiving and worked on the school's garden throughout the fall and spring.

Notably, every year the entire school would spend one week in the mountains, a few yards from the Appalachian Trail, living and learning in large barracks built during the Great Depression by the Civilian Conservation Corps. It was a unique blend of pop-up school and vision quest. There, lessons were centered on natural science, ecology, geography, theater, and storytelling; however, it was the community building and carefully crafted peak experiences that have endured most prominently in the memories of the graduates.

The teachers were radical collaborators, and every year new instructional ideas were tried with students. If they did not work, they were discarded, and if they did work, they were further refined and developed. Regularly, there were college students observing the teacher's use of these new strategies, just as Dewey had envisioned the role of the laboratory school. It was a place where innovation was part-and-parcel to the functioning of daily life, and the *vibe* was one of collective joyful learning. This experience provided me with the blueprint of what an innovative school looks and feels like.

Meeting Reality

My elementary experience seemed to me perfectly natural, and I had no reason to think it was out of the ordinary. I then matriculated into the comparatively larger junior high school. In place of educators with a progressive spirit was a functional yet middling standards-based education. The school was perfectly acceptable by formal standards, but lacked a *raison d'etre.* Although my education was adequate, each day felt like a cosmic punishment; humdrum teachers, lifeless lessons, a dull physical environment; programmed monotony, tiresome and

uninspiring assignments, stale opinions, and the overvaluation of tedious fussiness all functioned in concert to tame youthful spirits. I vividly remember watching the clock's minute hand painfully move through what seemed like an eternity. In short, school was *boring*. There were exceptions, of course, and excellent teachers dotted the experience, but overall junior high and high school felt like an orchestrated play in which the actors executed their assigned parts without any heart.

Skipping forward a quarter of a century, I find myself in an administrative role, leading teams of teachers and administrators. I am now an insider in the traditional public educational system, and determined to be more than a cog in the machine that produces the same-old-same-old. Much has been written about the negative effects of standardized testing on instruction, how the system was developed for the needs of the industrial revolution, and how it no longer prepares students for the future. Although these concerns may be true, my elementary school experience primed me to believe that our real root cause issue is a pervasive professional culture fearful of innovating its own solutions. At best, those seeking to bring about positive change refer to the authority of "best practices", which is to say that which has already been done before. Even the well intentioned are seeking to implement what others have safely established as acceptable, and as such, improvement looks like a search for the right off-the-shelf program, curriculum, or method that has already received a stamp of approval. Compounding this aversion to innovation are the national level educational policy initiatives, one after another, that each promise to be the next panacea. When each initiative predictably fails to deliver on its lofty promises, it quietly fades into the background to be forgotten. These challenges combine with an incentive structure that does not reward solution making and punishes failed genuine efforts, thereby creating the perfect storm that prevents a culture of innovation from flourishing.

Daring to be Different

I had the good fortune of being invited to attend a "Design Thinking Bootcamp" course at Stanford University's Hasso Plattner Institute of Design in 2017. After wandering through their building, I was struck by the complete lack of technology. At best, a room may have a projector. Instead of the glitzy technological tools and toys I was expecting, rooms had abundant supplies of sticky notes and black markers. Once the sessions got underway, it become clear that the d.School believed that innovation is found in our minds, not through things or tools. As the hours turned into days, I was introduced to dozens of methods to rethink how I approach that which I already understood, ways to supercharge collaboration, and a set of skillsets that led me to believe that *I* can solve really difficult problems.

At the conclusion of the first day of the bootcamp, my immediate thought was "I feel so creative." I thought maybe it was the tall cup of coffee, or perhaps the spring sunshine. With repeated exposures I came to realize it was this thing we were doing – *design thinking* – that was making me, and the people I work with, consistently and predicably develop novel and creative solutions. I came to see that DT is a scaffolded methodology that instills the confidence and courage necessary to think differently, and that it has this effect repeatedly on widely varying groups who choose to use this tool. Since then, myself and a team of other education leaders have been leveraging this method to help tackle the problems we each face in our respective roles, and we have witnessed how design thinking multiplies creativity, collaboration, and solution making.

In spite of the myriad of systematized constraints that exist, from standardized testing to taxation structures, educators still possess tremendous power to make changes that can positively impact students. As such, it is incumbent upon us as educators to embrace the power we have.

Within each of our spheres of influence lies an opportunity to transcend demoralization, and to rise to the challenge of seeing ourselves as nothing less than agents of innovation. We simply need to see that there is room for us to act, and to have the confidence to take ownership of that space. I believe DT may offer those of us trying to innovate the student experience a means to systematize and scale a successful approach to making the world tomorrow just a little bit better than it was today.

Chapter 1: Introduction

Design thinking (DT) began as an attempt to provide artificial intelligence with a coding procedure to solve problems that do not have a clear solution (Simon, 1969). By trying to help computers learn how to solve nuanced problems, a new way of framing and solving highly complex challenges, or *wicked problems*, was developed and transferred out of the narrow field of Computer Science, and into the wider world of human problem solving (Rittel & Webber, 1973). Further developments in proto-DT identified its fundamentally human nature and connection to the arts (Elsbach & Stigliani, 2018), eventually cementing DT as a stand-alone Liberal Art (Cross, 2001).

The term "design thinking" originated in the 1970's, but was made popular through the work of Tim Brown, the CEO of the design firm IDEO in the early 2000s. Brown and others, recognized that DT needed incorporation beyond the confines of design firms and departments as a required business strategy to foster innovation (Brown, 2008). IDEO's key insight for what defines DT is the idea of forthrightly inserting the human experience into the design process in what came to be known as "human centered design". A further development and clarification of DT is the contrasting of designers to their academic peers; DT practitioners do not generate new knowledge, test theories, or validate hypothesis, but rather translate observations into insights, and those insights then drive the design of new and innovative solutions to complex, or wicked, problems (Brown, 2011).

Design thinking itself can be hard to procedurally define, as a wide variety of DT systems developed, and each practitioner will come to favor a particular DT approach. To name a few, IDEO identifies three design phases: inspiration, ideation and implementation (Brown,

2011); Stanford University's d.School describes five stages of design: Empathize, Define, Ideate, Prototype, and Test (Wolniak, 2017); and the Luma Institute describes three modes of design work: looking, understanding, and making (Luma, 2020). Although DT practitioners will come to prefer a particular methodology; the common themes of valuing humans, radical collaboration, intentional team diversity, a bias toward action, low fidelity life-sized prototyping, a habit of *show don't tell,* and a preference for visual language and storytelling over analytical reports are all common concepts that bind the alliance of design thinking procedural methodologies together (Groeger & Schweitzer, 2014). Fundamentally, DT is a systematized approach to innovative solution finding, and promises to help design teams better meet the needs of those for whom they are attempting to solve wicked problems (Harvard Business Review, 2021).

Design thinking makes people and teams more innovative (Brown, 2019), and changes institutional cultures so that they are more conducive to creativity and solution making (Seitz, 2019). Long standing enterprises are predictably hindered in their ability to be innovative as a result of the institutionalized entropy that develops over time from their scale, longevity and previous success. DT is a countermeasure to these specific challenges faced by established institutions, and creates the conditions necessary for innovation within existing organizational structures (Ney & Meinel, 2020). DT produces the same positive impacts when applied to K-12 education, as it does in the business sector (Diefenthaler et al., 2017; Parker, 2020). These improvements to K-12 education come from DT's unique ability to upend entrenched institutional cultures that are rewarded for procedural replication and reliability, by shifting toward a reward culture that embraces ambiguity, collaboration, constructive feedback, and iterative improvements (Elsbach & Stigliani, 2018; Ney & Meinel, 2020; Seitz, 2019). Education systems that align their institutional cultures around DT, produce an ever-increasing set of

student-centered solutions that over time form a radically new child-centered school culture (Schrand, 2016). Not surprisingly, DT is an effective method for helping teams develop new schools (Wise, 2017).

DT positively impacts teachers' ability to design curriculum, instruction, physical spaces, and collaboration, specifically professional learning communities (Parker, 2020). Likewise, DT shifts the focus toward collaboratively designing the learning experience with students, and away from designing for the students. Additionally, DT allows teachers to question nearly all assumptions about how their classroom is organized with regard to lesson pacing, resource selection, the role of the teacher, the arrangement of the physical space, and so on. Lastly, DT allows teachers to determine what ideas warrant further development by testing lesson prototypes with students, and engaging students in the unit and lesson design process. (Diefenthaler et al., 2017; Cordova et al., 2017). Above all, DT improves K-12 education's ability to solve wicked problems (Parker, 2020).

Focus of the Study

This study focused on the skills and abilities developed by education leaders and teachers who utilized design thinking as a methodology for program implementation, professional learning community procedures, unit and lesson planning, and classroom management system designs. Utilizing a qualitative intrinsic case study design, I: (1) interviewed as they described their experiences with using DT to orient both their professional practice and the experiences of students, (2) observed educators' methodology for discussing and working through wicked problems within collaborative teaming environments, (3) and evaluated program, unit, and lesson designs to determine the role DT had in their production.

Rationale and Significance

Design thinking, sometimes referred to as “designerly ways of knowing”, is in its early stages of implementation in the K-12 educational environment (Koh et al., 2015). The first applications of DT to this field were at the administrative and curriculum development level but is now increasingly being implemented as a unit and lesson planning procedure, and a specific transferable learning target for students K-12 (Diefenthaler et al., 2017).

In the 21st Century, developed economies require a skillset from its workforce that highlights a wide range of amorphous and hard to define skills, that nonetheless paint a sketch of a shift toward critical thinking, collaboration, problem solving, and innovation (Panke, 2019). This shifting of emphasis is a change from the 20th Century’s focus on discrete content and skill mastery that more easily aligns to traditional models of standardized assessment and professional certification. Aligned to this change, DT has features that make it an excellent candidate for a methodology that when applied gives leaders and teachers the skills they will need to improve the current educational system (Diefenthaler et al., 2017).

An important component of the shift being required by the 21st Century context is the reuniting of the personalized needs of humans with the technical sciences and skills we employ to make our world a better place. Again, DT offers a specific methodology to bridge this gap, especially in engineering where DT is becoming a standardized component of engineering school curricula (Leifer and Meinel, 2016).

Empathy is the starting point for the design thinking process, and this important shift of placing the needs of the people being designed for ahead of practical concerns and considerations is a hallmark of DT and often results in teachers more carefully crafting student-centered learning experiences and solutions to student behavioral concerns (Curedale, 2019). When

applied to classroom settings, DT improves the ability of students to empathize with their end users and to create more human-centered solutions (Latremouille et al., 2015).

Design thinking also demonstrates important elements of social emotional development amongst leaders in ways that specifically align to the needs of 21st Century thinking. When using design thinking, individuals view themselves as change makers (Diefenthaler et al., 2017), perhaps the most important overarching requirement to be successful designers. The concept of designers inhabiting seven specific mindsets is linked to successful application of DT (Rauth et al., 2010), and people exhibit these mindsets at greater degrees when exposed to the DT process (Kelly, 2016). Also, those who embrace the seven mindsets express a belief in their ability to change the world (Diefenthaler et al., 2017). Designers are also better able to embody the modalities, or faces, of innovators as described by Tom Kelly (2016), and thereby bring innovative solutions to the problems they face.

Problem Statement

The use of leadership frameworks originally developed for the business sector, and later applied to education, is well researched. For example, current research suggests that distributive leadership, transformational leadership, creative leadership, and systems thinking have the clearest crossover from business to education (Hubbard & Datnow, 2020:, Groeger & Schweitzer, 2014, Sohmen, 2015; Mononen, 2017). Although these leadership frameworks center on increasing the functionality of current operations, they do not address creative innovation and problem solving of “wicked problems” (Rittel & Webber, 1973). Thus, design thinking offers a compelling case for being a thought process that can best support educational institutions seeking to foster abductive reasoning and creative thinking within their leadership ranks (Menguc, Auh, & Yannopoulous, 2014; Filippetti, 2011).

While the business sector has aggressively implemented DT as a methodology for creating innovative solutions to long-standing challenges, education has been behind the curve in utilizing DT for the same purposes and to the same extent. Much of the research on DT in education focuses on the use of DT as a curriculum for students, and specifically the measurement of the impact of DT on students. There is less research on the use of DT as a means of innovating our nearly century-old traditional public education system. A broader aspect of this field of research is a call to find methodologies to preserve public systems of education as we know them to strengthen them against alternative reform movements. This indicates the need to conduct case studies in those places that are employing DT at the leadership level to impact the student experience and learning environment. This study seeks to specifically explore the aspects of leaders' and teachers' application of design thinking to see how it impacts their development of the Eight Design Abilities of Creative Problem Solvers which is aligned to creativity and effective problem solving.

Research Questions and Design

The purpose of this study was to examine education leaders and teachers' utilization of design thinking as a methodology to identify and solve problems, and more specifically to draw out the experiential nuances of the leader and teachers experience as well as to study the relationship between use of DT and the development of the Eight Design Abilities of Creative Problem Solvers. Thus, the study's research questions were:

(1) Experientially, what is it like to implement design thinking as a problem-solving tool in a traditional K-12 public school system?

(2) How does the use of DT manifest as competency in the Eight Design Abilities of Creative Problem Solvers?

The case study will be most effective in answering these questions if it is designed to (1) learn about the holistic nature of the interrelationship between the participants' experience of using design thinking, (2) allow for real-time empirical observations of DT in action, (3) enables the researcher to interact with participants and engage in interpretive intuition when collecting and evaluating data, and (4) makes space to grasp the vicarious experiences of the participants. (Yazan, 2015). These requirements are fundamentally qualitative in nature, and suggest the need for interviews, observations, and document reviews. As such, this intrinsic case study design is guided by the structures outlined by Robert E. Stake (1995).

The case centers on a group of education leaders and teachers who have had previous training in the use of design thinking, and currently employ that methodology on their teams as a means of guiding their Professional Learning Communities, unit and lesson design, and crafting the experiential and behavioral experience for students. This study used a qualitative intrinsic case study design, utilizing three methods of data collection, namely: (1) education leader and teacher interviews, (2) observation of the practice of DT by education leaders and teachers in team meetings, and (3) a review of product production by the teams using DT.

Rationale for Methods

The purpose of this research is to gain an understanding of the trials, tribulations, successes, and skills developed by those utilizing DT as a problem-solving methodology. The primary aim is to explore the experiential nature of the implementation of design thinking, and how DT impacts teams' creative confidence and capacity to solve the complex problems they face; expressed through the 8 Design Abilities for Creative Problem Solvers. An intrinsic case study design was used to highlight an individual case of DT implemented in a traditional K-12 public high school, within a team of leaders and teachers implementing design thinking.

The intrinsic qualitative case study utilized field observations, interviews, and document reviews. Field observations included leadership meetings, professional learning community meetings, and unit planning sessions as a means of viewing the use of design thinking in action. The focus of the interview questions were on the experience of using design thinking as a methodological tool to determine the views of those implementing the DT process. Document review included a look at those products produced as a direct result of DT work at the leadership and teacher level. These documents included professional learning programs for teachers, systems protocols developed for teacher teams, unit and lesson plans, culture and behavioral designs, and other products resulting from the use of DT.

Limitations

This study was limited by constraints found common to case study research aligned to the work of Robert E. Stake (1995). The small sample of education leaders and teachers that participated in the semi-structured interviews, meeting observations, and document production limited the degree to which the findings are generalizable to the larger population of educators applying design thinking in their own settings. The selection criteria of participants for the study identified individuals who had exhibited commitment to the use of design thinking prior to the study, limiting the degree to which findings can be applied to K-12 education writ large.

Qualitative data was derived from interviews, observations, and document reviews. All three of these sources may have provided misleading data as participants may have chosen to share information that presents a rosier picture of reality in order to provide the researcher with the information they perceived the researcher wanted to hear. This perception is possible, as the researcher was also in a position of leadership within the school district that was the setting for this study, and the power dynamics of that relationship may have influenced the responses,

behavior, and products observed throughout the study. To remedy this concern, no participants were included in the study who are formally observed or evaluated by the researcher. Similarly, the researcher has previously invested time into the application of design thinking, and as such may have been subjectively motivated to see, and not see, evidence and data that may have been relevant to the evaluation of the study overall. To overcome this limitation, the researcher incorporated systems of notation and memo cross referencing, and participant approval of analysis and results.

As with most case studies, this study would be difficult to replicate, particularly as a result of the previous training in design thinking the participants received prior to their participation in this study, and the team oriented-nature of the secondary team being researched. To conduct similar case studies in other locations would be time consuming and cost prohibitive, especially when considering the need to provide in-depth design thinking training prior to the beginning of the study. Lastly, the subjective nature of case study research provides general limitations to applicability beyond the specific case studied in this research.

Definition of Terms

A set of essential terms are defined and described below to provide the reader with some central concepts necessary for further reading.

Design Thinking

Design thinking is a non-linear, iterative process that teams use to understand users, challenge assumptions, redefine problems and create innovative solutions to prototype and test. It is most useful when tackling ill-defined or unknown problems (Brown, 2008)

Wicked Problem

A wicked problem is one that is difficult to solve as a result of incomplete, contradictory, and changing inputs to the problem. Wicked problems are typically hard to solve, and single solutions or previously developed solutions rarely alleviate the problem. The term wicked relates to resistance to resolution, is connected to its use as a slang term in New England, and is not correlated with evil (Rittel and Webber, 1973).

Empathy

The first stage of the Stanford d.School's design thinking methodology. During this phase of design, designers put themselves in the proverbial shoes of their users to connect with how they might feel about their problem, circumstance, or situation. It is fundamentally a skill that allows designers to share feelings with others to ultimately derive an human understanding of the wicked problem seeking a solution (Walter, Woolery & Schaljo, 2019; d.School at Stanford University, 2022).

Define

The second stage of the Stanford d.School's design thinking methodology. The define phase is hallmarked by two essential actions. The first is to organize the information gathered during the empathy phase in such a way as to construct a schema of understanding about the user that is human-centered. The second action is to distill the organized empathy data down into a single defining statement that incorporates the human centeredness of the empathy data collection with deep insights from the design team to form a launching point for all further design development (Walter, Woolery & Schaljo, 2019; Wolniak, 2017; d.School at Stanford University, 2022).

Ideate

The third stage of the Stanford d.School's design thinking methodology. The ideate phase is where designers generate a wide range of potential solutions to the define statement developed in the previous phase. The aim of the ideate phase is on developing a large volume of ideas through creativity and collaboration (Wolniak, 2017; d.School at Stanford University, 2022).

Prototype

The fourth stage of the Stanford d.School's design thinking methodology. The prototype phase is where designers develop simple experimental models of a proposed solution that is used to test and validate ideas, design assumptions and other aspects of its conceptualization quickly and affordably, so that designers can reconnect with users prior to further development and to make appropriate refinements and changes (Walter, Woolery & Schaljo, 2019; Wolniak, 2017; Uebernickel et. al., 2020).

Test

The fifth stage of the Stanford d.School's design thinking methodology. After the prototyping phase has produced an adequately refined prototype that can be launched to potential users, designers will engage in a process of limited launches and beta testing to learn the nuanced areas for further refinement, and to take an experimental observational lens when witnessing how users interact with the solution (Uebernickel et. al., 2020; Wolniak, 2017).

Abductive Reasoning

The lesser-known partner to inductive and deductive reasoning. Abductive reasoning is the process of deriving the best possible prediction, or proposed solution, from a knowledge environment that features incomplete information, highly complex input and output

relationships, and unstable or changing information. From a design thinking lens, abductive reasoning is the method of solving wicked problems (Oster, 2008).

Systems Thinking

A holistic approach to analysis that puts attention on the way that a system's various parts interrelate and how systems operate over time and within the context of larger systems. It is a methodology to develop an accurate schema of the operational life highly complex and large institutions (Manonen, 2017).

Creative Confidence

Creative confidence is the quality that human-centered designers rely on when making creative leaps, trusting their intuition, and following potential solutions they have not entirely developed, yet. It is the belief in that a designer can, and will, develop a creative solution to a wicked problem and the subsequent confidence that it is simply a matter of time before the solution is found. It is the belief that as a designer you possess creative ideas, and all that is required is to uncover them and act accordingly (Kelly & Kelly, 2013).

Universal Design for Learning

Universal Design for Learning (UDL) is a method to plan instruction that gives all students equal opportunity to succeed. The essential aspects of UDL, are its methods for offering students multiple means to learn the targeted objective. UDL call on the teacher to develop multiple means of (1) gaining student cognitive engagement, (2) ways of comprehending the information, and (3) modalities for expressing what was learned (Hickey, 2021).

Professional Learning Communities

A professional learning community (PLC) is a group of educators that meet regularly, shares expertise, and work collaboratively to improve instructional skills, student academic

performance, and to plan future units and lessons. The term is also applied to small-group collaboration as a form of professional development. Professional learning communities tend to serve two broad aims: (1) improving educator instruction and content knowledge through collective study, exchanging expertise, professional dialogue, and planning, and (2) improving the educational success and aims of students through improved leadership and teaching (DuFour et al, 2021; Taylor, 2020).

Understand by Design

Understand by Design is a framework that is based on the idea that teaching should help students transfer their knowledge to other academic settings and to real word applications. It is hallmarked by a process of designing backwards from a learning goal established by an educator, and backfilling the learning experience to be oriented toward that learning goal (Wiggans & McTighe, 2006).

Progressive Education

A philosophy and instructional method, originally developed by John Dewey, that emphasizes the need to ground learning in (1) experiential knowledge that is rooted in real-world application and understandings, (2) a child-centered focus that sets aside the concerns of adults to ensure that the school environment and learning experience is oriented toward the student, and (3) the development of specific skills that allow for successful living in a democratic republic, and in communities in general (Dewey, 1899, Dewey 1910, and Dewey 1939).

Innovationism

Innovationism is a belief in the power of positive change to occur at the level of society through the use of innovation, technology and advancement. It holds that the fundamental challenges faced by mankind can be overcome by developing superior means than those we

currently have, and the belief that these means are capable of being developed technologically within the near-future (Bell et al., 2020).

Eight Design Abilities of Creative Problem Solvers

The Eight Design Abilities of Creative Problem Solvers are a set of mindsets and actions that are commonly employed by practitioners of design thinking (Kelly, 2019). The design abilities allows designers to focus less on the procedural nature of design thinking, and instead aim toward a more behavioral view of their collaborative work (d.School, 2020). Overall, having an abilities focus allows for a deeper understanding of the actions that allow *design* to happen.

Summary

Design thinking is a systematized approach to solving highly complex problems through the use of innovation and creativity, and likewise, DT promises to help organizations better solve those wicked problems (Harvard Business Review, 2021). Utilizing the DT process makes individuals and teams more creative (Brown, 2019), and changes institutional cultures so that they are more conducive to innovation and problem solving (Seitz, 2019). DT has been shown to be a countermeasure to institutional entropy, and creates the conditions necessary for innovation within existing organizational structures (Ney & Meinel, 2020). There is evidence to suggest that when applied to K-12 education, DT has similar positive effects as it does in the business sector (Diefenthaler et al., 2017; Parker, 2020). Specifically, DT pulls the carpet out from entrenched institutional cultures that have been traditionally rewarded for continuity by shifting the reward structure to embraces ambiguity, collaboration, constructive feedback, and iterative improvements (Elsbach & Stigliani, 2018; Ney & Meinel, 2020; Seitz, 2019). Education systems that adjust their culture to a DT mold, produce more student-centered solutions that form new

child-centered school cultures (Schrand, 2016). Above all, DT offers K-12 education a methodology to solve wicked problems (Parker, 2020).

This study seeks to explore the experiences of a group of education leaders and teachers as they use design thinking as their primary modality for problem identification and solving. The identified participants have previously been trained in the use of design thinking, and are currently implementing this process in their respective professional roles. The essential focus of the study is to explore the experiential reality of using design thinking in a K-12 public educational setting, and to examine how the implementation of DT is manifested through the Eight Design Abilities of Creative Problem Solvers.

Chapter 2: Literature Review

Design thinking (DT) is an intellectual procedural framework that helps teams produce innovative solutions to challenging, complex and nuanced problems (Brown, 2019). DT started as a narrow field related to artificial intelligence, but steadily expanded into nearly every domain of human endeavor including technology, business, science, governance, defense, and more recently K-12 education (Koh, Chai, Wong & Hong, 2015).

Within the domain of K-12 education, the implementation of DT applies to three specific areas: (1) DT as a modality for problem solving at the institutional and leadership level, (2) DT as an intellectual modality for teachers developing lessons and classroom culture, and (3) DT as a modality for students to develop into designers, as well as, traditional scholars (Koh, Chai, Wong & Hong, 2015).

This study seeks to explore the connection between design thinking as an applied theoretical innovation framework, and its practical application within a traditional K-12 public education setting by exploring educators' experiences using DT. The research on design thinking largely centers on its implementation within the fields of technology and business, and as such the research on the experience of implementing design thinking into K-12 education is sparse. This lack of research includes the impacts of design thinking as a pedagogical practice, its use as a system level leadership and organizational approach, and the experiential realities of using DT to solve problems in K-12 public education. Although parallel assumptions are made between available research on corporate use of design thinking, and its expected outcome in education; this area remains largely unresearched (Hubbard & Datnow, 2020).

The Emergence of Design Thinking

The path from a methodology for strengthening artificial intelligence to a generic teaching procedure to develop a constructivist educational pedagogy is a winding one. This historical review will link together the philosophical foundations of design thinking, its emergence into a free-standing liberal art, and its generalized application as a procedural framework to understand the potential design thinking holds as a K-12 leadership and pedagogical practice.

The Roots of Design

Herbert Simon's (1969) *The Sciences of the Artificial* was written with the aim of uniting the social sciences with problem solving in order to build a science of design. This goal was fueled by two desires: (1) To establish a human scientific process of design, and (2) to lay the foundation for artificial intelligence in computers. Simon began by establishing that modern humans live in an artificial world, one of layers of human cultural and technological development. In this sense, the science of the artificial is about how things ought to be, the development of goals, and the functionality within the broader artificial system. Simon (1969) asserts that human problem solving, at the cognitive level, is a systematic search in a labyrinth of potentialities. In order to function in this environment, the mind utilizes a selective search strategy to reduce the volume of that needing processing. Thus, he claims that design thinking is a theory of search. According to Simon, the key to solving a problem is representing it so as to make the solution self-evident. This in turn makes the goal of a human (or artificial intelligence) designer to reveal the most satisfying of alternatives to the problem (Simon, 1969). Design thinking, as we understand it today, builds off of these essential ideas. The developments, refinements and theories described below all orient back to Simon's groundbreaking work.

Development of Design Thinking Through Critique of Simon

Many designers in fields such as architecture, art, engineering, urban planning, and others were drawn to Simon's (1969) grand narrative but offered a series of critiques in an attempt to bridge his conceptualization of design within the confines of computer science to the broader Liberal Arts. Although this critique came from many corners and contained significant differences and variations, there was unity in their rejection of Simon's grounding of design within a positivist epistemology. The designers looking to expand upon Simon's initial concepts were pragmatists that borrowed heavily from John Dewey (You, 2019).

Although not direct critics of Simon, Horst Rittel and Melvin Webber (1973) were the first to put forward a key concept that competes with Simon's ideas regarding the presumed emergence of solutions once a problem is properly clarified. Rittel and Webber's idea was that the artificial world contains within it innumerable "wicked problems". A wicked problem is one that is not only highly complex, but due to its ambiguous nature it is impossible to clearly define. The recognition of the intractableness of wicked problems is an essential critique of Simon, and an essential theoretical building block for what would later develop into what we now know as design thinking (Rittel and Webber, 1973).

Donald Schön (Smith, 2020) delved into the distinct limitations put onto design when viewed through a technical and rational lens, particularly its view that design is essentially a problem-solving procedure. He asserted that in addition to problem-solving, a designer's key role was problem-setting, or the process of defining the problem itself. Schön explains that problems do not present themselves to the designer, but must be decoded from the puzzling, troubling, and uncertain pieces of evidence related to the issue at hand (Smith, 2020). It was Schön who put a human face to the design process and focused on the messy types of problems designers roll their

sleeves up to solve. He emphasized the necessity of utilizing our artistic and intuitive nature to be the most successful designers possible (Elsbach & Stigliani, 2018).

Richard Buchanon (1992) advanced design as a broader approach to be applied throughout multiple disciplines. He was a self-described pragmatist and heavily informed by John Dewey. He viewed design as a confederation of systematized thinking procedures that together form a unified Liberal Art and integrative discipline. Buchanan highlighted the radical intellectual space required by designers to operate, and in this sense rebuked Simon's limiting of design within an empiricist and positivist paradigm (Buchanon, 1992). In a similar vein, Nigel Cross (2001) specifically criticized Simon's epistemology of positivism and technical rationality. He pointed out that designers have their own particular view of the world and a set of procedures to make sense of the world that are unique to designers. These "designerly ways of knowing" are not linked to specific professional or academic domains, but are their own set of designer practices. The most poignant area of departure from Simon is Cross' adjustment of Simon's idea that design is a science to the notion of design as a standalone discipline (Cross, 2001).

Simon inspired a generation of admiring critics seeking to strengthen and widen his ideas, and perhaps most importantly they sought to humanize his original conceptions. It is from this place that we begin to see a move away from the purely philosophical conceptions of design thinking's intellectual father figures, to its application in a human centered world for the purposes of helping mankind tackle "wicked problems".

Design Thinking as We Know it Today

The term "design thinking" has been promoted and popularized by Tim Brown in his seminal paper *Change by Design* in 2011 and subsequent book of the same title, although the

term originated in the 1970s. The interest in design thinking was the recognition that innovation in a global economy was nothing less than a required business survival strategy. This recognition that design was simply too important to be left to designers, and that it needed to be incorporated more broadly, is the genesis of the design thinking prevalent today. Brown's key insight for what anchors all utilizers of design thinking is the idea of rigorously inserting the human experience into the design process through an intensive process of observation designed to collect quality, over quantity, data on users in what has come to be known as "human centered design". Brown is forthright in stating that designers are contrasted to their academic colleagues in that they do not seek to generate new knowledge, test theories, or validate hypothesis, but rather to translate observations into insights, and those insights then drive the design of new products, services and/or experiences (Brown, 2011).

Design Thinking as an Action Oriented Process

The precise process and procedures of design thinking varies from practitioner to practitioner, although the same core concepts emerge in all design thinking systems. For example, the IDEO approach identifies three phases: inspiration, ideation and implementation (Brown 2011); Stanford University's d.School describes five stages of design: Empathize, Define, Ideate, Prototype and Test (Wolniak 2017); and the Luma Institute describes three modes of work: looking, understanding, and making (Luma 2020). Regardless of the preferred procedure, common themes of valuing humans, radical collaboration, intentional team diversity, a bias toward action, low fidelity life-sized prototyping, a habit of *show don't tell*, and a preference for visual language and storytelling over analytical reports are common concepts that bind the confederacy of design thinkers together (Groeger & Schweitzer 2014).

Perhaps the defining feature of design thinking is the centrality of action. Design thinking is fundamentally not an academic experience, but rather one of process and intellectual movement. David Kelly (2016) has described DT as an antidote to “analysis paralysis”. As such, the key resources for general designers emphasize scripted experiences, activities, and collaboration techniques to be selected from to move the design process forward. IDEO provides resources batched by the stage of design thinking a team finds themselves in and offers potential experiences the designers can choose from in their *Field Guide to Human-Centered Design*. The Luma Institute’s *Innovating for People: Handbook of Human-Centered Design Methods* is a bedrock text for guiding the design process through a series of exercises organized within three broad phases. *The Design Thinking Toolbox* provides a matrix with 48 different activities cross referenced with Stanford University d.School’s five stages of design thinking as a means to target the appropriate design experience for a given design need. The best representation of the idea of action selection can be found in Robert Curedale’s tomb *Design Thinking Process & Methods* which provides instructions for 458 different activities in which teams can engage, each selected for their appropriateness as informed by the current needs of the design thinking challenge.

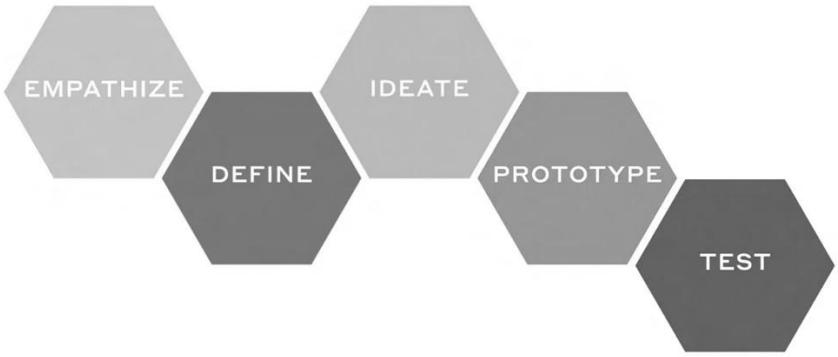
The utilization of specific types of design thinking tools creates predictable changes to the design outcome. For example, information gathering tools that require designers to engage in interviews, empathy exercises, ethnographies, and journey mapping produce user-centric cultures. Idea generating tools, typically thought of as brainstorming, produce a liberated culture hallmarked by openness to ambiguity, risk taking and collaboration. Lastly, idea testing tools, such as rapid prototyping, small scale models, and fast-testing contribute to cultures of experimentation, openness to failure, and user-oriented thinking. (Elsbach & Stigliani 2018).

The Hasso Plattner Institute of Design at Stanford University's Five Phase Process

Although dozens of DT methodologies are available to use, one method that is commonly used is the process developed by the Hasso Plattner Institute of Design at Stanford University, more commonly known as "the d.School", in partnership with IDEO. This position of common usage is largely due to the depth of training materials developed through the d.School's website, and within the sphere of education their recent development of the "K-12 Lab" to specifically tailor design thinking methodologies to the needs of schools. The d.School's process breaks the design method into five stages that are completed in a semi-linear fashion from project start to finish, however there is significant shifting back and forth between stages throughout the design process itself.

Figure 1

The d.School's five phase design thinking process



Note: Although many methods exist, the d.School's method is ubiquitous. Reprinted from "Design Thinking Hexagons" By Stanford University d.School. Creative Commons.

Empathy. The empathy phase is a foundational concept within design thinking, and is largely what distinguishes DT from other innovation models. Empathy is fundamentally about immersing oneself in the user's experience as a method for uncovering deep needs and insights

about the user. It calls designers to journey into the feelings and experiences of others to gain new perspectives on the lives of your users to better understand their challenges, what keeps them up at night, and their moments of delight (Walter, Woolery & Schaljo, 2019). For example, Standord's d.School K-12 Lab hosted a "School Retool" design thinking exercise where principals shadowed a student from bus stop pickup to drop off, and every minute of the school day in between. The principals followed all school rules, snack and restrooms usage limitations, and behavioral expectations placed on students, and they had to engage in all lessons, lunches, and recesses as though they were a student (d.School at Stanford University, 2022).

Define. The define phase takes the experiences, data, and stories of users from the empathy phase and synthesizes the user experience to ultimately form an actionable problem statement that acts as the intellectual anchor for all the design work that proceeds after this phase (Wolniak, 2017). The aim is to reframe the user's problem in such a way that the design process continually reconnects with the user experience through the uncovering of deep insights about the user's fundamental needs (Walter, Woolery & Schaljo, 2019). For example, in the School Retool exercise, one principal formulated the problem statement "Students need a way to feel a sense of home and comfort while at school, however the entire school day is experientially institutionalized" (d.School at Stanford University, 2022). The define statement then serves two essential functions in the DT process, (1) it encapsulates the insights discovered during the empathy phase, and (2) it acts as the springboard for the remaining stages of design.

Ideate. The ideate phase centers on generating a range of potential solutions to the problem statement articulated during the define phase (Wolniak, 2017). The essence of the ideate phase is that it is a time for designers to engage in open-minded idea exploration, with an emphasis on producing a wide range and high volume of potential ideas for further incubation

and development in later phases (Walter, Woolery & Schaljo, 2019). The ideate phase is a time for creativity and collaboration, with the aim to not allow any one idea to gain a grip on the team's focus to ensure that new ideas continue to emerge and be considered as potential solutions (Brown, 2016).

Prototype. Prototyping within a DT framework works through rough conceptual prototypes, often starting with cardboard three dimensional expressions of physical ideas, or a wall of organized ideas on sticky notes or sketches to conceptualize service or non-physical ideas. Prototyping is an ongoing learning process, a place to solve design disagreements, and a method for testing ideas quickly and cheaply to see what works and what does not (Uebernickel et. al., 2020). An essential characteristic of DT prototyping is a heavy emphasis on prototyping early; not over developing an idea before launching it to users (Wolniak, 2017). Pushing out low fidelity prototypes to test with users is an essential ingredient in being able to ensure that user experience is inserted throughout the development process as prototypes become higher and higher resolutions of a final concept (Walter, Woolery & Schaljo, 2019).

Test. Once the cycle of rapid prototyping has led to a solution that is complete enough to launch to users, the test phase calls on designers to strategically implement limited and beta testing environments to learn about the nuances and experiential impact the solution has on users (Walter, Woolery & Schaljo, 2019). In some sense, the test phase calls on designers to engage once again in the empathy phase to reconnect with the user experience and smooth out the design prior to launching in larger or more permanent applications (Uebernickel et. al., 2020; Wolniak, 2017).

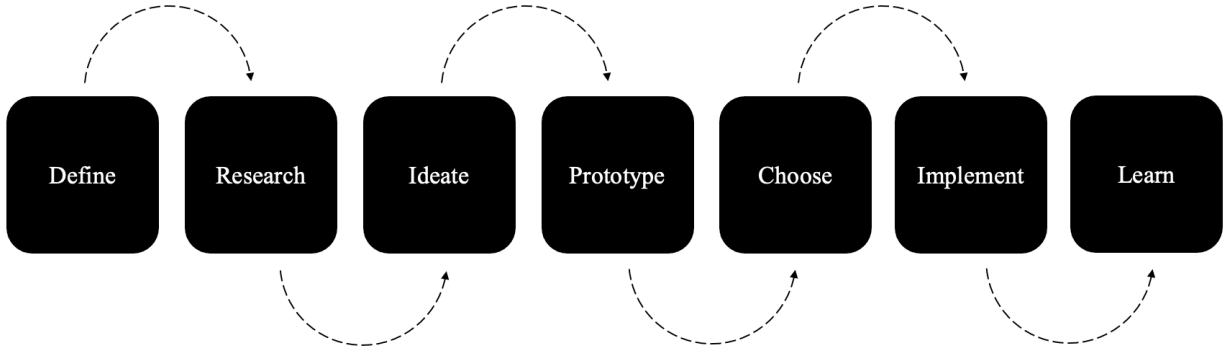
Other Methodologies of Design Thinking

Although the d.School method may be a dominate voice within the design thinking space, a wide variety of other methodologies, each with their own unique approach, are in frequent use by design thinkers. Some are generalized methods, like the d.School approach, but with different design foci, while others were developed for specific types of design problems or industries (Expert, 2022). Regardless of their differences, nearly all design thinking approaches (a) contain calls to empathy work, (b) seek to reframe the problem in new terms, (c) employ divergent thinking to expand the pool of solution possibilities, (d) employ convergent thinking to shrink the pool of solution possibilities to a single preferred idea, and (e) they all leverage prototyping and iteration (Dam & Siang, 2023).

The Original Design Thinking Method. One of the earliest methods of design thinking was Herbert Simon's (1969) seven stage process which laid the groundwork for all subsequent DT methodologies, and contained all of the essential components of a successful method. Nearly all DT methods are adaptations of this original conceptual framework.

Figure 2

Herbert Simon's Seven Stage Design Thinking Method



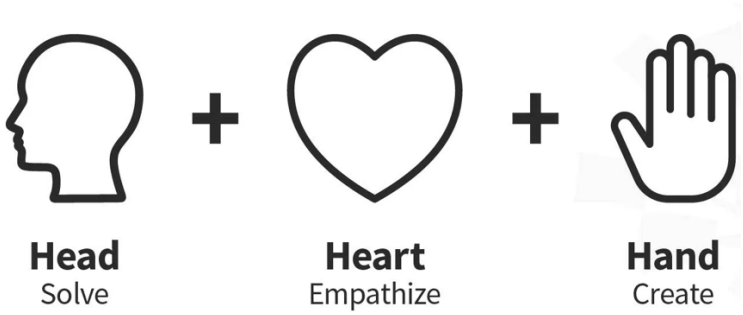
Note: One of the original DT methods that still defines the field today.

Over time, design thinking methodologies have evolved to include deeper approaches to empathy, increased collaboration, and greater emphasis on multidisciplinary work (Dam & Siang, 2023).

Head, Heart, and Hand. The American Institute of Graphic Arts (AIGA) has an approach that emphasizes the blending of designer mindset and skillsets. Their approach is less linear than most methods, and places a heavy emphasis on designers engaging in their work holistically, and being able to bring a different part of their own talents and abilities to bear when problem solving, depending upon the needs of the design work at that time (AIGA, 2022).

Figure 3

The American Institute of Graphic Arts Head, Heart and Hand DT Approach

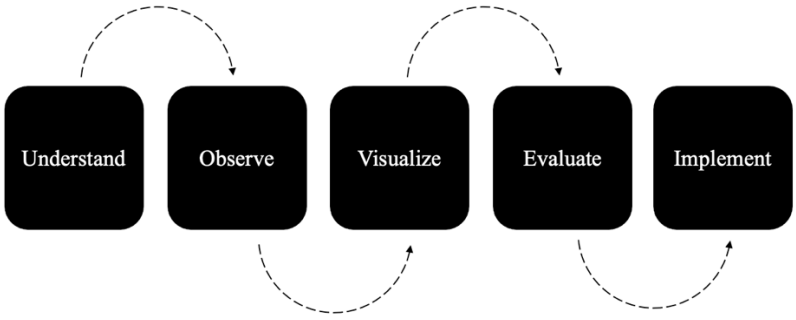


Note: The AIGA method centers on employing the designers' skillsets and mindsets holistically. The AIGA methodology differs from some of the more generalized approaches, in that it presumes that practitioners are in professional design roles (AIGA, 2022).

DeepDive. Another method that modified Herbert Simon's work to specifically enable a group to quickly immerse themselves into a situation so as to effectively generate solutions to the problem is the DeepDive Methodology (Roethler, 2018).

Figure 4

The DeepDive Design Thinking Methodology

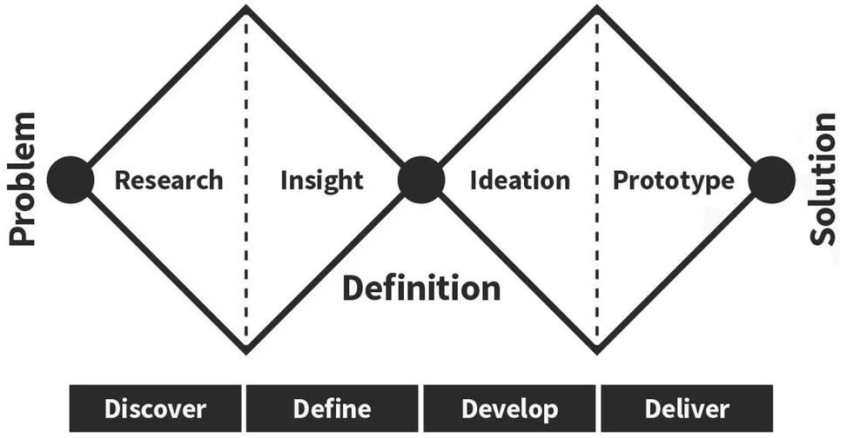


Note: The DeepDive approach gets design teams up to speed quickly to solve problems. Where this process most clearly distinguishes itself is in the doubling up of the empathy phases, by specifying the need to "understand" and "observe". In this sense, the process does not leave the empathy phase process entirely up to the designers, but rather forces the use of two different empathy methods (Roethler, 2018).

The Double Diamond Design Process Model. The Double Diamond Design Process Model places specific emphasis on the divergence and convergence dynamics found within all DT methods. Their approach seeks to center the designer's methods around the expanding and contracting aspects of DT. It was developed for the British Design Council whose work supports social, economic and environmental problems; however, this methodology has been utilized by DT practitioners for a wide range of needs (British Design Council, 2022).

Figure 5

Double Diamond Design Process Model



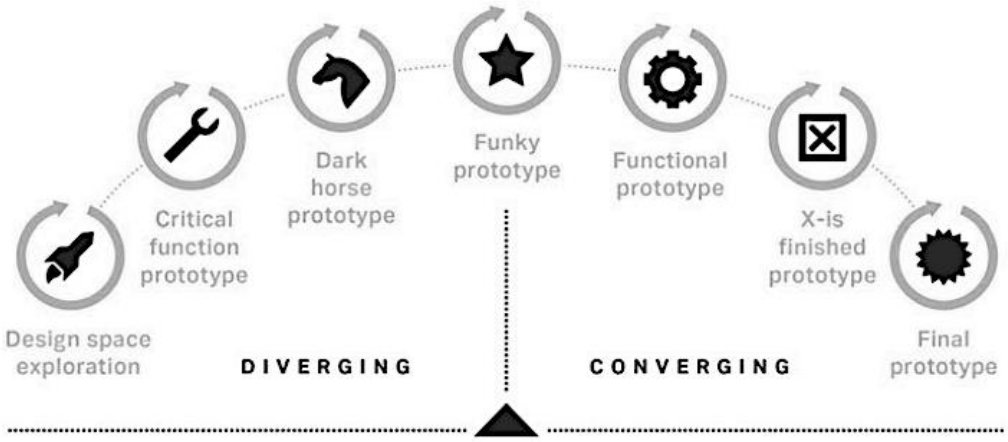
Note: Developed for social, economic, and environmental problems, but useful for all designers. Adapted from "Double Diamond Design Process Model" By British Design Council. Creative Commons.

The Double Diamond Design Process Model moves the design work through a linear four phase process of (a) discover, (b) define, (c) develop, (d) and deliver; with each phase ending in either divergence or convergence (British Design Council, 2022).

The Macro-Process Method. Falk Uebernickel's Macro-Cycle methodology breaks from the d.School mold. In this approach each phase of the design process has its own discreet goal that is developed through a micro-cycle, with each micro-cycle containing complete empathy, define, ideation, prototyping and testing phases. When the micro-cycles are placed together, they form the Seven Phase Macro-Cycle (Uebernickel, 2020).

Figure 6

Falk Uebernickel's Seven Phase Macro-Cycle



Note: Each phase of the Macro-Cycle is its own complete DT Micro-Cycle. Adapted from *Design Thinking: The Handbook* (page 37), By F. Uebernickel et. al., World Scientific Publishing Company. Copyright 2020 by World Scientific Publishing Company. Reprinted with permission.

The Macro-Cycle shifts the emphasis of the DT process away from creating a final product, and instead employs it to move the design process itself forward one step. By shrinking DT down to smaller pieces, a wider array of DT activities and tactics can be employed to move solution making closer to completion. This process also helps narrow the focus of what designers are attempting to accomplish at any one given time (Uebernickel, 2020).

And Many More. There are many other design thinking methodologies that have been developed, and as there is no authoritative governance structure, new methods are being developed by practitioners every year. Other common methods include (a) Stage-Gate, (b) Pentathalon, (c) The Donut Method, (d) Stuart Pugh, (e) Circular Chaos, (f) The Spiral Approach, (g) Designing for Growth, (h) "NPD", (i) The V-Model, (j) Waterfall Method, and (k)

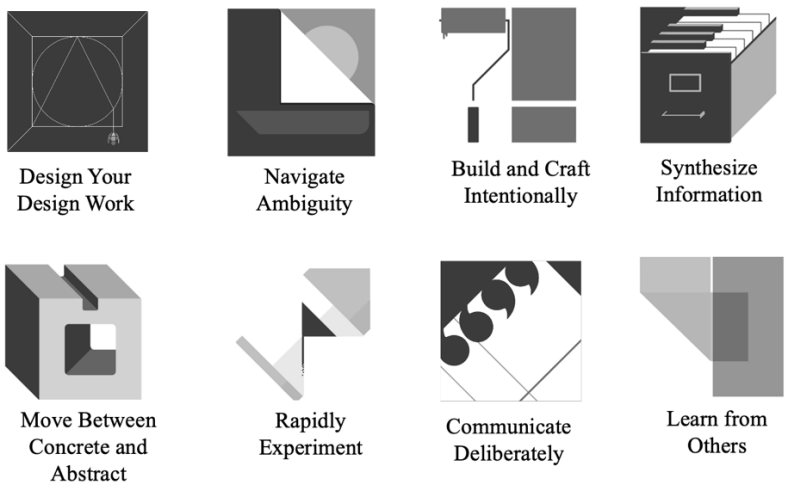
a modified d.School approach called Design Thinking for Social Justice that incorporates four additional phases prior to Empathy. These examples are just a few of the options that designers can utilize to tailor their methodological choices to the needs of their design problem (Dam & Siang, 2023).

The Eight Design Abilities of Creative Problem Solvers

In addition to the procedure, process, and actions of design thinking, a recent development within DT has been a focus on the qualities that make for a superior designer functioning within a design thinking framework. In a recent podcast and subsequent article, the CEO of IDEO, David Kelly, called upon the design community to focus upon the individuals who make up the design thinking team and to establish a common set of values that design thinking practitioners embody (Quinn, 2020). The d.School has created a set of 8 Design Abilities with subsequent attributes that can help individuals and teams seeking to be better designers learn how to embrace the qualities that lead to great design work. They describe how designers need to (1) navigate ambiguity, (2) learn from others, (3) synthesize information, (4) experiment rapidly, (5) move between concrete and abstract, (6) build and craft intentionally, (7) communicate deliberately, and (8) design your design work (Stanford, 2020). This recent focus on design attributes over the design thinking process is largely a corrective measure to ensure that design thinking is not only human-centered in its systematization, but also human-centered in its evaluation of those engaging in DT work.

Figure 7

The Eight Design Abilities of Creative Problem Solvers



Note: The associated artwork for each ability was crafted by the Stanford d.School. Reprinted from "Eight Design Abilities of Creative Problem Solvers" By Stanford University d.School. Creative Commons.

Navigating Ambiguity. Navigating ambiguity is arguably not only a design ability, but also the overall goal of all of the design abilities when working together. It is sometimes represented as uniting all the design abilities as the primary function of all design work. A designer must embrace the emotional discomfort of having no clear path to success in order to uncover and develop an innovative solution to a problem (Kelly, 2017). Although part of this ability is about gaining confidence to living with uncertainty, it is also about developing a toolbox of tactics to overcome ambiguity and lead oneself to clarify a path and develop solutions (d.school, 2019).

Design Your Design Work. To "design your design work" is to view the problems and challenges the design team faces as nothing more than projects, because once problems become projects the task becomes manageable (Kelly, 2017). Once that intellectual hurtle has been

cleared, the designer can now view the project as a design problem (d.School, 2019). To solve design problems, practitioners develop plans for what kinds of design work they will engage in to see their way through the process of solution making. The act of crafting the design experience is the heart of this design ability (Kelly, 2017).

Learn from Others. "Learn from Others" is fundamentally about actively seeking collaboration. However, it is not merely a call to engage in committee work, but rather a push to not think in isolation. This design ability dares to suggest that working harder is not the way to discover innovative solutions, but rather to hear from many relevant voices. (Kelly, 2017). It is also about seeking views from those with different vantagepoints on the problem at hand, and repeatedly testing ideas through a process of iteration, critique and feedback (d.School, 2019).

Build and Craft Intentionally. Build and Craft Intentionally is all about designing something in which others can see, use, and interact (Kelly, 2017). At its core, this design ability is about thoughtful construction of things and experiences in order to show users a meaningful and concrete expression of a potential solution (d.School, 2019).

Synthesize Information. Within design thinking, synthesis is often discussed as "convergence", which is to say the opposite of divergence. It is all about canvasing what has been learned and condensing it to a single core understanding that is used as a launching pad for all future design work. Design thinking is unique in its focus on teasing out insights and opportunities as part of its synthesis process (d.School, 2019). Developing the ability to synthesize information is essential for designers as qualitative and quantitative data has to be analyzed through a DT lens. Designers leverage DT methods and activities, and they employ abductive reasoning to analzye their users and design challenges (Menguc, Auh, & Yannopoulous, 2014; Filippetti, 2011).

Communicate Deliberately. Engaging in careful, purposeful and thoughtful communication is an essential design skill, and is critical to a project's success (Kelly, 2017). This ability is also about forming, capturing and relating one's ideas to others, and to do so in such a way that it moves the design process forward. It is tightly associated with "Design your Design Work" in that it is a call to use methods of communication that are premediated in their format to ensure that it supports the advancement of design (d.School, 2019).

Move Between Concreate and Abstract. This design ability is about juggling: (a) the need to maneuver through conceptual ideas developed intellectually, and (b) bringing those ideas out of the intellect and operationalizing them in the real world (Kelly, 2017). This ability safeguards design work from falling victim to one of two extremes: (a) the tendency for knowledge workers to become lost in abstraction, and (b) the tendency for practitioners to view the here-and-now as all there is to see (d.School, 2019). Moving between the concrete and abstract is not a "middle ground", but rather the act of jumping from one modality of thinking to another (Kelly, 2017).

Rapid Experimentation. Rapid experimentation is a foundational action for design thinkers. Above all else, it is about creating rough prototypes quickly, and getting those prototypes in front of potential users in order to receive feedback (Kelly, 2017). It is about the rapid generation of ideas, followed by developing those ideas to be tested by others for the purposes of critique, thereby enabling further prototyping. As a design ability, it is about designers reaching out to users to beta test and provide insights on what is and is not working with the design as it is, and doing so with minimal time spent trying to perfect each iteration (d.School, 2019).

Design Thinking as an Interdisciplinary Discipline

Design thinking is fundamentally interdisciplinary in how it processes information in order to derive a holistic human centered solution. As such, a distinct aspect of design thinking application is the formation of firms, departments, and organizations whose sole purpose is to act as a neutral space where design thinking work between siloed departments, subjects and/or organizations happens. Perhaps the most famous of these is IDEO, a firm specializing in the innovation of products. Companies will hire IDEO to help their own teams navigate complex and dynamic challenges to produce practical and human-centered innovations (Leavy, 2010).

Some universities have established their own colleges or departments dedicated to design thinking which are unique from traditional colleges in that most do not have credit generating courses, nor do they offer degrees. The purpose of the design college is to work with administrators, faculty, and students from all corners of the university who are trying to innovate solutions, and to guide their work through the process of design thinking. The quintessential example is Stanford University's d.School, but there is also the Manage by Designing school at Case Western Reserve University, Integrative Thinking at the University of Toronto, Nexus at Jefferson University, Innovation Design Engineering at Imperial College London, Keio University's Graduate School of Media and Design, and the new Global Innovation Design program. The addition of design colleges is in some sense a revolution in higher education as universities explicitly seek to break down barriers between expertise areas by investing an institution whose sole purpose is to bring diverse experts together in the name of progress and innovation.

There have also been design thinking offices established within larger corporations which seek to do much the same as the design colleges at universities. General Electric and IBM are

perhaps the earliest adopters of this method, but they were soon followed by Samsung, Deliotte, Accenture, and McKinsey. There is a proverbial explosion of design thinking across the corporate landscape in the recent years as companies seek greater competitive advantages (Kolko, 2015). And why is this significant, why does it matter? Much like universities, large corporations seek to benefit from the interdisciplinary nature of design by *forcing*, in the nicest way possible, potentially competitive branches of their organization to work together for the greater good of the business.

Design Thinking and Organizational Culture

Design firms and other small firms centered on design thinking have a culture focused on *what* should be done, whereas traditional organizational cultures have a greater focus on *how* work should be done. As such, a design thinking centered team uses abductive reasoning (the process of deriving the best prediction from incomplete knowledge), is inclusive of ideas, and is problem based (Oster, 2008). In addition, design firms show five specific areas of culture that marks them as distinctly different from traditional corporations: (1) Workflows are project based and temporary, (2) high status is derived from having a track record of finding solutions to wicked problems, (3) the style of work involves undefined roles, extensive collaboration, brainstorming sessions, and constant dialogue, (4) the mode of thinking is abductive, as opposed to inductive or deductive, (5) and there is a dominant attitude that constraints are viewed as an opportunity (Martin, 2005). These attributes together make for a foundation that results in the necessary culture required for creativity, innovation and the flourishing of design.

The Measurable Impact of Integrating Design Thinking on Organizations

As corporations were the first adopters of design thinking as an organization-wide approach, there is evidence of its effectiveness as a positive influence on business performance

regarding growth (Chiva & Alegre 2009), profit generation (Gemsera & Leenders 2001), and stock market values (Hertenstein, Platt, and Veryzer 2005). Aside from traditional performance metrics, there is evidence that integrating design thinking into corporate cultures produces a demonstrably more innovative organization (Menguc, Auh, and Yannopoulous 2014) and businesses that utilize design thinking outside the design department produce more innovative products (Filippetti, 2011).

Design Thinking and Other Organizational and Leadership Frameworks

A common area of interest for design thinking implementers and researchers is the combining of the design thinking process with leadership frameworks that will help support the efforts of bringing design thinking to an organization. Distributive leadership is a common framework selected for its impetus to share decision making power across a wide range of participants (Hubbard & Datnow 2020), and as a way to place people in positions of relative powerlessness directly into roles of influence and ownership (Nuzzaci, 2010). In some ways similar to distributive leadership, the Transformational Leadership Model is a methodology that can help those seeking to integrate design thinking into their organizations as it focuses on the leadership characteristics of being charismatic, inspirational, intellectually stimulating and individually considerate (Groeger & Schweitzer, 2014). Similarly, Creative Leadership, with its focus on leading by fueling vision, spawning novel ideas, crafting diverse methodologies, and producing innovative outputs, is linked to design thinking and specifically the ideas of David Kelly in his design thinking centered text *The Ten Faces of Innovation* (Sohmen, 2015). The linking of design thinking to various leadership frameworks is often sought out due to the recognition that design thinking is simply a process, and as such requires thoughtful leadership to ensure its success.

When thinking about design thinking and its implementation within organizations, the Systems Theory approach can act as a partnering framework for individuals in leadership roles within large organizations seeking to implement design thinking within a broad range of other processes and procedures already in place (Manonen, 2017). Systems Theory leaders have a broad range of attributes that can help when bringing design thinking into an organization including, but not limited to, thinking about a systems' overall purpose ahead of its processes and procedures, a preference for synthesis over analysis, seeking to understand the system as a whole, creating feedback loops, and seeking continuous improvement (Tate, 2009). This approach helps the leader to form a complex puzzle of the organization, understand leadership as its own system within the organization, and to see the addition of design thinking as a cog within the larger system (Mugadza & Marcus, 2019).

Design Thinking in Education

Within the domain of K-12 education, the implementation of DT applies to three specific areas: (1) DT as a modality for problem solving at the institutional and leadership level, (2) DT as an intellectual modality for teachers developing lessons and classroom culture, and (3) DT as a modality for students to develop into designers, as well as, traditional scholars (Koh, Chai, Wong & Hong, 2015).

Design Thinking and Educational Leadership

Design thinking may have a similar impact on K-12 Education as it has been demonstrated to have in business. For leaders in K-12 Education, DT specifically targets two areas of current deficiency: (1) Education's inertia with regard to institutional change, and (2) a lack of creativity at the leadership level when developing schools, programs and systems (Diefenthaler et al, 2017).

Design Thinking as a Method for Institutional Change. DT has been shown to produce innovative solution makers (Brown, 2019) and to foster the cultural shifts necessary to form an innovation-oriented institutional culture for ongoing innovation production (Seitz, 2019). DT can also act as a necessary antidote to a perennial problem that plagues large institutions; namely entropy as a result of the scale, longevity, and gravity of success in mature enterprises (Ney & Meinel, 2020).

Although the application of DT to the K-12 educational context has occurred more recently than in business and government, when done correctly, it produces similar innovative outcomes, shifts and improvements (Diefenthaler et al, 2017; Parker, 2020). These improvements largely stem from DT's particular ability to shift entrenched cultures focused on reliability and continuity toward a culture that embraces ambiguity, radical collaboration, constructive conflict, opportunity seeking, empathy, and gradual iterative improvements (Elsbach & Stigliani, 2018; Ney & Meinel, 2020; Seitz, 2019). These shifts empower rigid educational institutions to reimagine how they are organized and operate, and allows them to radically reorient tooffer students a refreshing and user centered experience (Schrand, 2016). Similarly, DT is an effective tool for establishing new schools from drawing board to ribbon cutting (Wise, 2017).

Within the K-12 educational environment, DT shows particular promise to impact the design of curriculum, approaches to pedagogy, the design of physical spaces, organizational processes, and the tool and systems utilized by the institution (Parker, 2020). Likewise, DT in education shifts the focus toward "designing with" and away from "designing for" the local community. It opens the door to begin questioning all assumptions about how school is organized with regard to start times, textbooks, teacher roles, room arrangements, summer break,

and so on. DT allows schools to learn what ideas hold potential for further development through small scale prototyping, such as micro-schools that operate are R&D laboratories. DT simultaneously allows leadership to design for scale by prototyping small, while anticipating the need to go big (Diefenthaler et al, 2017; Cordova et al, 2017). Above all, DT improves a school system's ability to solve extremely hard to grapple with complex challenges, often referred to as *wicked problems* in DT jargon (Parker, 2020).

Design Thinking as a Method to Increase the Creative Confidence of Leaders and Teachers. Creativity is often associated within a narrow band of expression, typically associated with music, art, dance, theater, etc. However, the technology revolution has highlighted that creativity goes well beyond this stereotypical and limited description. Creativity is nothing less than the ability to create new ideas (Kelly & Kelly, 2013). Similarly, innovation is often mistaken for or limited to grand and highly novel and ground breaking ideas. In fact, innovation is the gradual integration of new ideas, folded and weaved into existing knowledge structures that eventually, over time, lead to improvements (Kelly et al., 2001). The goal of arming education leaders with the skills needed to unlock their own creative abilities, and build confidence in their ability to be creative, is a necessary prerequisite for leaders and teachers to be innovative contributors and to live full and enriching professional lives (Robinson et al, 2011).

DT is the best-known systematized approach to showing people how to be creative in modalities beyond the arts. As such, DT is a key tool in developing creative confidence (Kelly & Kelly, 2013). A challenge facing the development of greater creative confidence in education leaders and teachers is its association as an inherited trait, that it is viewed as mysterious, and current educational policy does not support the development of or an appreciation for creativity (Henriksen et al, 2017). Utilizing DT builds educational leader and teacher creative confidence

through the repetition of the DT process, continuous exposure to wicked problems, and questioning initial belief systems. Leaders and teachers who use DT report an increase in their ability to be creative. An important factor in transitioning from a beginner to an expert "creative" is integrating DT until it is operating on the level of intellectual automaticity (Rauth et al, 2010).

Design Thinking and Teachers

Design thinking shows promise as a methodology to help teachers center their lesson design on holistic student needs, and to support teachers in improving their overall capacity to structure student experiences. To do this, teachers must transform their own professional self-image from a deliverer of content to a designer of learning. Teachers will need support in making this transition, and once complete DT shows particular alignment as a method to layer into the curriculum design process.

The Teacher as Designer. Designing student experiences is perhaps one of the most important elements of a teachers' professional practice that occurs outside instructional time (Danielson, 2013). High quality experiential design is also fundamental to the emotional impact it has on users, the degree to which they personally identify with that experience, and the likelihood that a person will want to reengage with that experience (Rossman & Duerden 2019).

Teachers have turned to DT as a way to deepen the way they plan for students, and this shifts their role toward that of *teacher as designer*. Teachers as designers of learning broaden their scope beyond the four walls of their classroom to embrace a more interdisciplinary approach to learning design (Bartlett, 2021). This move to a design mentality is doubly important as the demographics of the student body in the United States shifts away from a majority White population toward greater diversity (Johnson, 2017).

When teachers employ DT, it places them into the modality of Human Centered Design (HCD). A set of principles has emerged that HCD teachers use: (1) maintain a stance toward inquiry, (2) work towards grasping and explaining the real problem, (3) keep empathy woven throughout the design process, (4) recognize that professional designers have implicit knowledge that cannot always be captured by teachers, and (5) keep in mind that design is about human dignity (Becker, 2021). When these aforementioned principles are brought to bear upon the Universal Design for Learning (UDL) approach, the outcome is the weaving together of a technical lesson design methodology with the human centeredness of DT. UDL blends easily with DT due to its assumption that students have individual learning needs that can be met with proper design (Hickey, 2021).

Teachers who have been exposed to DT, and especially those who employ it as a technique, recognize that it improves their practice in a variety of ways. DT teachers are recognized as being "humanistic", they challenge traditional modalities of thinking, they are more mindful of others, more creative and critical, have a deeper understanding of their students, and interestingly they feel DT gives them a counterweight to the modern youth culture of "I, me, mine" (Retna, 2015). Teachers utilizing DT also feel that it increases the number of instructional tools they have to foster collaboration and creativity amongst their students (Rauth et al., 2010). Teachers also notice that DT enables them to move their students beyond the relatively traditional project-based learning approach, to a more adult-like process of iteration and gradual improvement (Hennessey & Mueller, 2020).

Developing Teachers into Design Thinking Practitioners. In order for large educational institutions to shift toward a DT culture, it is essential that their culture shifts toward innovation, and this can only be accomplished through targeted professional learning experiences

(Ney & Meinel, 2020). A key starting place for this work is to move toward a design inspired form of leadership where empathy is central, teachers reimagine themselves as opportunity seekers and the architects of student experiences (Gallagher & Thordarson, 2018).

The way to move from a non-design inspired to a design inspired collective form of design leadership is through carefully selected DT tools and experiences that will lead a team toward becoming designers. Empathetic interviews, shadow safaris, photo studies, empathy maps, character composites, “how might we?” protocols, and rapid prototyping are just a few examples of the key tools that work best with teachers. What is notable is that teacher approval of the DT process increases dramatically after exposure (Nash, 2019). Similarly, the improvisational prototyping process of DT acts as vector for bridging the professional learning gap between PD workshop and classroom practice (Knudsen & Shechtman, 2017). Put more simply, design thinking creates design thinkers (Nash, 2019).

There are, however, roadblocks that can be anticipated along the way toward achieving a critical mass of DT oriented teachers. Most of these roadblocks are cultural in nature, and it is important that social spaces for exploration are created, a rich pool of diverse ideas is carefully fostered, an embracing of messy processes occurs, and that repetition leading to automaticity is gained over time (Ney & Meinel, 2020). Another key ingredient is to see the innovations developed through DT as ephemeral, and as such they are solutions for now, but they too will grow old just like the ideas they originally replaced (Seitz, 2019).

Numerous frameworks exist to guide the DT process. A guiding principle of all of them is that DT is itself a learning experience. As such, simply experiencing DT is to learn about DT. It is experiential (Boller & Fletcher, 2020). Proper planning is essential, and while the typical Stanford d.School five-step process is an obvious content requirement, it is important for DT

professional learning experiences to not gloss over the importance of the underlying rules at each of the stages of DT (Betancur, 2021).

Each individual exemplifies certain particular character strengths over others. Together a person's character strengths and weaknesses produce a profile (Peterson & Seligman, 2004). By centering the DT learning experience around an individual's character strengths, the positive benefits of DT are further highlighted. This is due to the social and collaborative functionality of the DT process. By allowing individuals to leverage their greatest strengths, as opposed to trying to mitigate against areas of weakness, the team as a holistic unit becomes more effective (Coyle et al., 2018).

Creating rigidly managed timeslots for DT to take place creates an atmosphere of constant time pressure. These time pressures privilege the immediate and social dimensions of a team over the factual dimensions. This creates an atmosphere where team members are equally participatory, resulting in a non-hierarchic experience that encourages all participants to come up with new ideas (Seitz, 2019). This core concept of limited time should be combined with the following core belief system or norms: All personalities provide necessary insights, working across disciplines is required, thinking of oneself as a T-profile (your vertical axis is your ability to provide deep knowledge, your horizontal axis is your ability to think interdisciplinarily), embody openness, be experimental, ask for help, be yourself, offer honest criticism, and have the courage to occasionally be childlike. Using these traits under tight time constraints produces the best results for design-centered teams (Uebernickel, 2020).

Teachers in many highly successful schools already participate in professional learning communities (PLCs). The core work and function of PLCs is to analyze student data in order to identify trends for students across subject areas and to develop plans to support students

academically and behaviorally (DuFour et al, 2021). DT fits nicely into this framework, but reorients the work of the PLC members from data analysts to solution finders and innovators. This moves the needs of the students to the forefront, links directly to instructional innovations for individual students, improves instruction overall, and generally leads to a more innovative school culture (Taylor, 2020).

Teachers often view the hierarchical structure in public education as an insurmountable obstacle. Encouraging teachers to rethink their relative power of influence, and to sign on to the idea that they have tremendous power to innovate in their current role, without any additional leadership support, is a key intellectual requirement to allow DT training to take hold in individuals (Couros, 2020). Understanding that innovation within education is not about sweeping changes, but rather a commitment of long-term incremental improvements is a core requirement to make meaningful change in our institutions (Couros, 2015). Embracing the idea of small iterative change over time, professional learning for DT should focus on the concept of "teacher sprints". This concept centers on three core ideas: Start with the best bets, practice makes for progress, and focus on tiny shifts. Taking these ideas together, teachers should learn about DT through a series of short professional learning sessions each finely targeted at a single area for development (Breakspear & Jones, 2021; Whitaker & Breaux, 2021).

Using DT to Develop Curriculum. DT positively impacts the development of a more human-centered curriculum (Parker et al, 2020). Although most DT curriculum development will still utilize the Understand by Design (UBD) framework (Wiggans & McTighe, 2006), DT can be woven throughout the process and will give a greater emphasis to the first phase (identify desired outcomes) and the third stage (plan learning experiences) of UBD. (Woodfin & Plaut, 2017).

As a curriculum process DT also embeds the idea that the student is the center of the design aim, and that the designed teacher role is one of coach or guide. By integrating DT into the UBD process, it also results in innovations to the curriculum producing more opportunities for student creativity and collaboration (Henriksen et al, 2018). There are three essential characteristics when building a curriculum using DT: (1) Experiential activities drive DT forward in a classroom setting, (2) having concrete real-world activities increases student engagement, and (3) build in natural consequences for poor or incomplete work (Aflatoony et al., 2018).

When DT is utilized to write curriculum, collaboration between teachers, a career that if often described as “siloed”, is markedly improved. Developing a course through DT makes teachers more confident in the idea of leading a DT course themselves, it deepens teachers understanding of both content and instructional techniques, and teachers feel as though their own critical thinking and problem-solving skills are improved (Shively & Palinonis 2018). Teachers also find that weaving DT into their curriculum writing process produces more creativity, collaboration, and efficiency of time as well as an improved sense of the curriculum design process and more effective instruction of the designed course (Crites & Rye, 2020).

Design Thinking, Project Based Learning and Makerspaces. DT favors pedagogical approaches that engage in active learning, especially Project Based Learning (PBL), problem-based learning, inquiry-based learning, the maker movement (makerspaces) and genius hour (Parker et al, 2020). The most common pedagogical link is to project based learning, as both approaches are expressions of a constructivist pedagogical approach (Boss & Larmer, 2018; Lee, 2018). DT and PBL are complementary to one another, and DT is employed as a tool in project-based learning classrooms (Parker et. al, 2020). However, significant differences exist between DT and PBL, and it is important for educators to recognize how the application of DT and PBL will produce different outcomes in students.

DT is a method that makes students become designers, whereas project-based learning can ask students to become whatever profession is associated with the given project (e.g., mathematician, scientist, author) . As such, DT employs "designerly strategies" alone as its methodology, whereas PBL takes from a more varied set of practices. DT has a greater emphasis than project-based learning on empathy, the discovery process for recognizing and solving problems, and encouraging observation and listening (Deifenthaler et al, 2017). DT uses a common language throughout its application in business, government, the tech sector and in classrooms, whereas project-based learning uses educational jargon that differs between PBL models and from school to school. In addition, these varying PBL languages are not transferable to the adult world (Lord, 2019).

From an instructional lens, DT requires teachers to take on the role of coach or "guide on the side" even more so than in project-based learning which requires a similar, though less extreme, approach (Deifenthaler et al, 2017). Project based learning explores a teacher or school determined subject area, and the essential question driving the project is teacher determined. In

contrast, DT explores any wicked problem identified by a student, for longer durations of time, and has students explore numerous lines of inquiry. The project produced in a PBL classroom is teacher selected, whereas DT has no limitations on what students will ultimately create (Lord, 2019). Overall, DT can be viewed as a method for students to identify and produce any project, whereas PBL is a teacher derived project aligned to specific content and skill development, often centered on a specific course or state learning standard.

DT is a perfect fit for the maker movement. What makes the maker movement distinct from project-based learning is its greater emphasis on allowing students a wide-open intellectual space when making, solving and innovating (Honey & Kanter, 2013). It is also an excellent methodology to use as the intellectual backdrop for students seeking to make working prototypes and real-world products (Anderson, 2021). To be effective in makerspaces, the DT process has to encourage excellence of production in order to maintain high standards for student expectations (Berger, 2003). This can be done by focusing on the already developed core competencies of the makerspace movement, but adjusting them to align to the phase of DT students are working within (Martinez & Stager, 2019). DT, PBL and Makerspaces are complementary to one another, however, their differences mark them as unique to one another and thus they are not interchangeable.

The Emergence of Standardized Design Thinking Syllabi, Curriculum and Professional Development. There is emerging research and supports that are beginning to standardize the framework for the development of DT courses. A group of researchers collected college level syllabi from universities spanning across 11 countries. The content, assessment criteria, scope and sequence, and time allotments were disaggregated and compared in order to form a cohesive generic syllabus that represents the broadest agreements across DT courses. A

key finding from the study was an agreement that relatively little time is given to the instruction of the basic five-step process, but rather the focus is on the rapid repetition of that process and how each iteration has a predictable theme, such as; the dark horse phase, the funky phase, and the final prototype phase. The course then pointed students toward an understanding of the goal for each iteration phase (Wiesche et al., 2018). Some educators have created potential frameworks for learning standards (Lee, 2022), and scope and sequence documents ([redacted], 2022). On the heels of this research has also been the formulation of training materials that align to the findings of the emerging generalized syllabi, standards, and scope and sequences (Uebernickel, 2020).

Design Thinking and Students

Implementing design thinking as an instructional model impacts student achievement in a variety of ways that mimics outcomes found in business settings. When teachers utilize design thinking as a classroom pedagogy it fosters student voice, increases measures of creativity, and improves measures of active learning (Carroll, 2010). Design thinking as an instructional model increases the likelihood of a teacher utilizing a constructivist teaching approach, it promotes positive student-teacher relationships, and supports student metacognitive skills (Scheer, 2012). There is also evidence that the interdisciplinary nature of design thinking supports students transfer of learning to different environments. Additionally, design thinking has a markedly positive impact on students who are low-achieving (Chin. 2019).

The Need for Design Thinking at the Student Level. Design thinking, or designerly ways of knowing, is in its early stages of implementation in the K-12 educational environment (Koh, Chai, Wong & Hong, 2015). The first applications of design thinking in this field was at the administrative and curriculum development level, and is increasingly implemented as a specific transferable learning target for students K-12 (Diefenthaler et al., 2017).

21st Century developed economies require workforces with skillsets that emphasize a wide range of amorphous and hard to define skills, that nonetheless paint a sketch of a shift toward critical thinking, collaboration, problem solving, and innovation (Panke, 2019). This shifting of emphasis is a change from the 20th Century's focus on discrete content and skill mastery that more easily aligns to traditional models of standardized assessment and professional certification (Robinson, 2011). As a compliment to new needs of business and industry, design thinking has features that make it an excellent candidate as a methodology that can be applied to give students the skills they will need to succeed in the future (Diefenthaler et al., 2017).

An important component of the shift being required by the 21st Century context is the reuniting of the personalized needs of humans with the technical sciences and skills we employ to make our world a better place. Design thinking offers a specific methodology to bridge this gap, especially in engineering where DT is becoming a standardized component of engineering school curricula (Leifer and Meinel, 2016).

Interestingly, empathy is the starting point for the design thinking process, and this important shift of placing the needs of the people being designed for ahead of practical concerns and considerations is a hallmark of DT (Curedale, 2019). When applied to classroom settings, DT improves the ability of students to empathize with their end users and to create more human centered solutions (Latremouille et al., 2015).

Design thinking also demonstrates important elements of social emotional development amongst students in ways that specifically align to the needs of 21st Century thinking. When using design thinking, students view themselves as change makers (Diefenthaler et al., 2017), perhaps the most important overarching requirement to be successful designers. The concept of the designers inhabiting a series of seven specific mindsets is linked to successful application of DT (Rauth et al., 2010) and students exhibit these mindsets at greater degrees when exposed to the DT process and they express a belief in their ability to change the world (Diefenthaler et al., 2017). Students are also better able to embody the modalities, or faces, of innovators described by Tom Kelly (2016).

Design thinking as an educational tool is a textbook expression of the constructivist approach to education, and as such it helps students develop a set of skills that do not translate well to standardized tests, but are closely linked with the needs of the 21st Century (Henriksen et al, 2018, Pande, 2020, and Pepperdine, 2019). Where standardized testing forces learners to be general, linear and repetitive, design thinking encourages understanding of a problem or issue in its deepest and fullest context (Lord, 2019).

How Students are Impacted by Design Thinking. The concept of “tools" within design thinking is a reference to a series of exercises that are typically performed collaboratively to actively engage in the design thinking process, for example, interviews, mind mapping, brainstorming, rapid prototyping, and beta testing (Curedale, 2019). It is through these tools that designers act out the process and develop their own skills as designers. These designerly skills include the economic requirement to be creative, the embracing of failure as a means to propel innovations forward, intellectual autonomy, frequent testing of ideas with end users, an insatiable need to continually collect feedback from others, radical interdisciplinary approaches, a drive to

make things experiential early on, and most importantly a mindset and culture of optimism and curiosity (Uebernickel, 2020).

Although design thinking is expressed in innumerable ways, its shorthand description as a five-step process has become a standardized way of framing the process (Walter et al, 2019). Each stage is associated with a menu of potential tools, and specific tools develop particular strength areas in individuals. It is predictable what specific areas of strength an individual will develop by tracking which tools they have utilized during the DT process (Elsbach & Stigliani, 2018). Growth areas as a result of the using DT tools include challenging designer assumptions, developing deeper understandings of the problem, developing clear visions for future development, generating new solution ideas, strengthening the bond between thinking and doing, and embracing an iterative view of innovation and improvement (Henriksen, 2017).

When comparing students' participating in a design thinking course to comparable students not enrolled in a DT course, those exposed to DT demonstrate superior abilities with regard to being solution-oriented, people-oriented, cooperative, optimistic, able to visualize into the future, creative, and possessing the ability to reflect upon their own process and to evaluate their experience (Revano and Garcia, 2020). Elementary aged students improve in all categories of the Four C's Skillsets of 21st Century Learning; (a) critical thinking, (b) communication, (c) collaboration, and (d) creativity (Pepperdine, 2019). In addition, DT positively impacts engagement, evaluation, refinement and presentation techniques (Lord, 2019).

Student engagement is often cited as the single most powerful instructional tool to improve student learning (Fisher et al, 2017), and one of the core goals for all curricula is to achieve successful transfer of knowledge (Wiggans and McTighe, 2005). Design thinking improves students' positive emotional impact and increases levels of cognitive engagement

(Melles et al, 2012). Likewise, when students learn content and skills through design thinking it increases their ability to transfer that knowledge to real world applications, thereby achieving the primary goal of education (Noel and Tsai, 2017).

Developing Creative Confidence in Students Through Design Thinking. Design thinking is the best-known systematized approach to showing students how to be creative in modalities beyond the arts. As such, design thinking is a key tool in developing creative confidence (Kelly &and Kelly, 2013). When students engage in design thinking, their ability to demonstrate creativity, ingenuity, and unique ideas increases relative to peers not exposed to the design thinking process (Panke, 2019; Ulibarri et al., 2015; Diefenthaler et al., 2017; Revano, 2020; Lord, 2019; Henriksen et al., 2017; Rauth et al., 2010; Melles et al., 2012; Pepperdine, 2019; & Retna, 2015).

Debates, Tensions, and Barriers to Implementation

Design thinking has increased in popularity since the early 2000s, particularly in the business sector. Much of the popularity around its use centers on the presumed promises it makes with regard to innovation, creativity and problem solving (Brown, 2008). With increased scrutiny and improper application, a host of critiques and criticisms have arisen; DT is poorly defined, it’s just the next buzzword, it lacks fidelity in implementation quality, it tinkers on the edges of what really needs to change, it is an incomplete methodology, current institutions are not prepared to integrate DT, and there remains a lack of standardization for teachers and students. For those seeking to gain the most from design thinking, taking these issues into serious consideration is an essential step to ensuring high quality application.

I Still Don't Get It

A search of design thinking frameworks yields dozens of different ways of conceptualizing and applying design thinking (Brown, 2011; Wolniak 2017; Luma 2020). This variety in DT conceptualization makes it difficult to clearly define what DT means (Kimball, 2009). This ambiguity leaves those attempting to implement DT with a lack of clarity around what, exactly, is DT. Although Stanford University's Hasso Plattner d.School has emerged as the prescriptive expression of DT that is most commonly referenced, many designers take issue with their approach and push back against the association of the term *design thinking* with the Stanford model. Additionally, this lack of clarity causes many to fear the enthusiasm DT generates (Vinsel, 2018). Similarly, DT's natural flexibility and lack of concrete definitions produces confusion and ambiguity, thereby losing the fight against the perception that DT does not require rigorous training and is therefore seen as "easy" (Diefenthaler et al, 2017).

It's a Buzzword

The recent popularity of design thinking has come to threaten its long-term use. As more and more practitioners do a poor job of implementing the process, it runs the risk of becoming diluted and a bi-word for something that does not live up to its promise (Ketterman, 2018). Similarly, the term design thinking is used as a panacea for organizational problems that require more than a one-day workshop presenting DT as the solution to all woes (Lahey, 2017). As such, DT is potentially on the path to becoming just another buzzword (Ketterman, 2018).

Leave it to the Experts

Similar to the issue of becoming little more than a buzzword, design thinking has a problem around implementation. Namely, the barriers to understanding the fundamentals of DT are relatively low, and so teams dive into the use of DT without having the experience or

expertise to effectively implement the process and derive high quality innovative outcomes. Oftentimes, DT requires nuanced knowledge of the process in order to effectively use it as a tool. This lack of nuanced understanding results in the presumption that it is ineffective (Fiasova, 2018).

A key concern amongst K-12 DT supporters is that the process is destined to become diluted and eventually meaningless in the hands of unskilled implementers (Diefenthaler et al, 2017). A key source of this failure would likely be a lack of instructional clarity as described by Fisher et al. (2018), and its negative impact on a design thinking experience's ability to produce positive outcomes for student learning (Aflatoony et al., 2018). Some DT supporters call for either a new buzzword to describe the *real* design thinking, or a renewed effort to clarify the difference between the garden variety and deep or "stacked" design thinking (Malbon, 2016).

Design Thinking Promotes the Same Old Same Old

Design thinking is fundamentally iterative, and relies on a particular process of checking back with users prior to further prototype development (Micheli et al., 2018). This user centric process can have the effect of producing improvements, as opposed to revolutionary change. For example, the iPhone was originally developed by Steve Jobs and his team without the aid of DT, and is an example of showing people what they want, instead of asking people what they want (Pierce & Goode, 2018). Although DT does place the user front-and-center in the process, some critics argue that it does not go far enough, and acts as a methodology for institutions to maintain power instead of truly distributing decision making and innovation (Iskander, 2018).

Design Thinking Needs a Friend

Design thinking is a particular way of interacting with knowledge and the world at large, in much the same way that the scientific method, engineering science, or art provide different

frameworks for engagement (Brown, 2011). As such, if the goal is to utilize DT as a broad methodology for institutions, it can be argued that DT is insufficient as a stand-alone approach. Although DT does incorporate aspects of different methods of observing the world, it is primarily an abductive reasoning methodology (the process of triangulating the best prediction from incomplete knowledge), and as such leaves inductive and deductive processes to other ways of thinking (Oster, 2008). As such, combining design thinking with the scientific method, systems theory, or any other established framework may lead to superior results due to a more balanced intellectual approach (Owen, 2007).

Public Education and the Metaphor about Square Pegs and Round Holes

Significant challenges face any large institution seeking to move toward a DT approach. These challenges all stem from the same core issue related to the inertia against change found in individuals, and collectively in the institutions themselves (Seitz, 2020). Specifically, within school systems, there are limitations as a result of the particularly risk averse culture found throughout education and the accountability centered culture of educational leadership which undermines the notion of embracing iterative failings (Parker et al, 2020). In addition, DT as a process can be overly time consuming relative to more traditional methods, and its implementation may be less well suited to particular subject areas, especially mathematics (Retna, 2015).

Uncharted Waters for Teachers and Students

Several challenges exist when thinking about making a shift to blending Understand by Design and DT together when engaging in curriculum creation. There is still a need to develop methods and measurements to assess creativity, innovation and other 21st Century skills associated with DT (Parker et al, 2020). Similarly, methods need to be developed to demonstrate

the effectiveness of teaching DT. There is a clear link between high income schools and districts and use of DT, as such it is important that we ensure that under-resourced schools and students have equal opportunities to benefit from DT (Diefenthaler, 2017).

Debates, Tensions, and Barriers to Implementation Conclusion

Design thinking holds out the promise to be a highly effective method for increasing organizational innovation and problem solving. A common theme that emerges in the critiques of design thinking are the twin evils of (a) poor application and (b) increasly widespread use. These two issues work together to produce the general conclusion that design thinking is the next trendy wannabe *panacea* that will not deliver on its promises. For those who have experienced DT's ability as a tool to foster innovation, these critiques challenge practitioners to ensure that design thinking is applied with finesse, expertise, and fidelity, so that its outcomes and products live up to the expectations of the teams who developed them.

Next Steps for Research

A core area for further research is to determine ways that the outcomes of DT in educational institutions and classroom can be measured objectively. Although the research shows commonalities in improvements to 21st Century skillsets, especially creativity, there needs to be further research on how to determine the overall success of DT as a methodology for improving these abilities. Also, a look into the impact of DT on more typical standardized testing is also important to inform educational leaders about the expected outcomes, good and bad, should they choose to incorporate DT into the curriculum.

The initial studies looking at how DT impacts students primarily centers on adult computer science students (Harel & Papert, 1990). There are studies that show how engagement, depth of understanding, levels of reflection, and self-regulation are improved when students

engage in design activities (Casey, Hastie & Rovegno, 2011;, Ching & Kafai, 2008;, Liljestrom, Engkenberg & Pollanen, 2013). Many frameworks create design experiences in the classroom, and more are developing. However, the connection between DT in the classroom and its support of 21st Century skills needed further exploration (Koh, Chai, Wong & Hong, 2015).

Theoretical Framework

The theoretical framework forms a lens that (a) views the core ambitions of the Progressive Educational Movement as timelessly relevant, (b) incorporates Systems Theory to have an accurate assessment of the institutional functioning of public education, and (c) centers design thinking itself as the methodology to bring about a more innovative future.

The Promise, Failure, and Promise of Progressive Education

John Dewey, the father of Progressive Education, argued that the participation of *all* individuals is a prerequisite for a properly functioning Democratic political process (Dewey, 1916). Additionally, he believed the success of the people's participation in the political process was predicated on the ability to identify and solve problems (Dewey, 1908). In *Democracy and Education,* he describes the ideal of democracy as "more than a form of government; it is primarily a mode of associated living, of conjoining communicated experience." He saw that for this participatory activity to occur, the people needed to be properly educated in the methods, discourses and values necessary for *rule by the people* to bloom not only in the halls of power, but also in the homes, businesses, churches, and social settings of everyday life (Dewey, 1934).

To strengthen the paired goals of (a) participatory government and (b) collective problem solving, Dewey sought an education experience that would deepen our experiment in representative government by training individuals in the ideals of a Democratic Republic (Dewey, 1916). Dewey's proposed approach is what we now know as Progressive Education;

grounded in (a) experiential learning, (b) a child-centered focus, and (c) the skills required for successful community living (Dewey, 1899, Dewey 1910, and Dewey 1939).

Progressivism then positioned itself as an alternative to Traditionalism (or "Old Education" as Dewey often dismissively referred to it) as the best means to improve upon the democratic experiment. During the early decades of the 20th Century, hundreds of schools were opened in the mold of Progressive Education, producing wildly varying results; from the inspiring success of a new strident democratic youth culture to utter failure producing little more than illiteracy. By the middle of the 20th Century, Progressive Education's theoretical promises had come under significant scrutiny not only by its academic opponents, but by parents unsatisfied with both the methods and results (Cremin, 1990).

Later in Dewey's career, after his theories had been applied for decades, he penned a cutting critique and sober call to action for those seeking to bring Progressive Education into the world in *Experience and Education.* He begins by praising the successes of hundreds of years of Traditional Education, and he extols the virtues of hard-won insights into curriculum and instruction learned through the ages. He lashes out at Progressive Educators' reflexive iconoclasm of all things Traditional and mindless parroting of new ideas. Most importantly, he called upon serious practitioners of Progressive Education to focus their efforts *not* on the critique of Traditional Education, but rather on the building and constructing of a viable Progressive Educational system that stands on its own as a serious and superior democratic education, not as a counter culture "alternative" (Dewey, 1938).

While the needs of the Cold War largely ended the progressive educational movement, the ideas and inspirations of Dewey continued to be developed throughout the 20th Century. Open classrooms, schools without walls, cooperative learning, multiage approaches, whole language,

the social curriculum, experiential education, and other forms of alternative schools all have important philosophical roots in progressive education (Koliba, 1999). John Goodlad's "nongraded" schools, Theodore Sizer's network of "essential" schools, Elliott Wigginton's Foxfire Project, and Deborah Meier's student-centered Central Park East schools are some examples of progressive reforms in public education (Cremin, 1990); in the 1960s, Paul Goodman and George Dennison took Dewey's ideas in a more radical direction, helping give rise to the free school movement (Miller, 2000). By the end of the 20th Century activist educators in inner cities had advocated greater equity, justice, diversity and other democratic values through the publication *Rethinking Schools* and the National Coalition of Education Activists (Levine and Au, 2013). Most recently, instructional approaches, most notably Project Based Learning, have been implemented as a way to insert some of the core values of progressive education into classrooms (Kokotsaki, Menzies & Wiggins, 2016). Although all of these schools and movements were inspired by Progressive Education, none of them have come anywhere close to the large-scale scope and aims originally sought by Dewey and his protégés. This suggests, and leaves room for, a fresh look at methods (for example, design thinking) to bring about a wholescale education system that is aligned to experiential learning, is student-centered, and prepares students to be community members and citizens.

Our School Systems as Systems

When thinking about meaningful change in our schools, we should consider not only thinking about classroom application of curriculum and pedagogy, but also about the functioning and interconnectedness of our education systems holistically. To help in this endeavor we can turn to Systems Theory as a way to better understand how our education system operates, and to help craft effective changes that will positively impact students.

During the Industrial Revolution, many organizational theorists and managers began to view their organizations as analogous to machines, including schools (Robinson, 2017). Their view was that organizations received certain inputs, such as raw materials, they processed those materials at an internal cost of time, money and labor and then produced an output that had a value, such as furniture, cars, or educated minds. The result was a mechanized way of understanding our highly complex institutions, including government and education.

Ludwig von Bertalanffy and James Miller both found fault in this mechanized way of viewing the world and sought to categorize and describe the ways in which systems in nature and those derived by man operated more as biological organisms than machines (Miller, 1965 and Bertalansffy, 1968). This work then opened the door for *The Social Psychology of Organizations* which specifically viewed human organizational life through the lens of sociology. This in turn formed the foundations for what is known as Systems Theory; a way of conceptualizing and understanding highly complex human organizations (Katz & Kahn, 1968).

Observing and evaluating an organization through a Systems Theory lens brings attention to the institution in three particular domains (Merker, 1985). The first is to see the organization as a holistic enterprise, not as a collection of silos or filters (Beckt, 1974). A common refrain in Systems Theory is to recognize that the organization is greater than the sum of its parts, by observing how the pieces are interdependent and provide feedback to one another. Overall, the aim is to form a map of all the interconnected systems and subsystems as a means to gain a high-level view of the organization as a social system.

The second domain is the role of feedback loops. A Systems Theory approach evaluates the forces of negative and positive feedback and how they influence the processes of the organization over time (Almaney, 1974). This includes a view of institutional reward and

punishment systems purposefully and unintentionally built into the fabric of the organization's functioning. For example, car salesman working on full commission may be simultaneously highly proactive and also saboteurs of their colleagues, or tenured teachers may be risk averse due to the low benefits and high risks related to innovation in a classroom setting. Feedback loops go beyond personnel management, and include communication systems, and the ways that the various silos and departments interact functionally and politically with one another.

The third domain is the existence of entropy. Systems Theory presumes that organizations have a predisposition to slow down, deteriorate, disorganize and become corrupt over time (Bailey, 2006). Entropy can occur in the form of an active run down in efficiency and proficiency, though it more often comes in the form of failure to adapt as conditions outside the organization change. The solution to entropy, according to Systems Theory, is to ensure that balance is achieved by inputting organizational change, energy, resources and information in the proper channels as a counterforce to help reach homeostasis or equilibrium.

The current public education system has its roots in the English school system, dating back to the 16th Century, and it can be argued that it even reaches back to the scholastic traditions of the Catholic Church in the early medieval period. With this as a base, our current system has 18th, 19th, and early 20th Century thinking layered into its operational framework (Cremin, 1990). It is surprising then, that little to no fundamental reform has occurred in the public education system of the United States in over 100 years. Much of what is referred to as reform, is more accurately described as revisions to the system, but the bedrock of that system remains unchanged (Robinson, 2011). Meanwhile, the top paying careers throughout the 20th Century remained relatively stable, but in the 21st Century only one of the top paying careers from the 20th Century remains on the list (Barley, Bechky, & Milliken, 2017). Although education does

not have clearly defined metrics for overall success, like business profits or military conquest, it can be argued that there is a fuzzy kaleidoscope of proverbial tea leaves, from stagnant standardized test scores to increasing populations of home schoolers, that provide evidence of the presence of entropy in our current public education system.

A systems theory lens can offer a way to unpack some of these challenges, and to help identify where to appropriately point innovations to improve the current system. For example, using the inflow/outflow feedback system approach we can see that the inflow of student prerequisite knowledge over the last 20 years has increased significantly with regard to technological skills, however the State of the System has changed relatively little by continuing to focus on Advanced Placement coursework as the highest expression of excellence, thereby producing an outflow of student knowledge and skills that is not markedly different from what would have been found 10, 20 or 30 years prior (Meadows and Wright, 2008); corroborated by the mismatch between the innovation and collaboration skills needed by businesses and the rote content knowledge and individualistic academic-centered skills being produced by our schools. This brief systems theory analysis points to the need to adjust the State of the System (curriculum and instruction) to produce an outflow more closely aligned to the qualities of an ideal candidate in the 21st Century hiring pool (Gore, 2013).

Innovation Through Designed Incrementalism

The Progressive Era of the late 19th and early 20th Century had an underlying belief in the power of our institutions to bring about positive changes in the world through reform. Progressive Education, a subdomain of this era, held the same beliefs specifically related to our educational systems (Kennedy, 1975). A similar faith in the power of positive change exists today, but in relationship to technology and other social changes, and it is sometimes referred to

as *Innovationism* (Bell et al., 2020). At its core, it is a belief that innovation will solve fundamental challenges faced by mankind.

Design thinking acts as a procedural methodology for teams of people to engage in innovation to derive unique solutions to highly complex challenges (Brown, 2012). In this sense, design thinking is one of the means by which *Innovationism* manifests itself. Design thinking assumes a brighter future is possible, and a prevailing assumption of optimism is an essential component of successful DT teams. The fundamental reason to engage design thinking in Public Education is to bring the positivity and potential of our innovative era into the institutions that our Progressive Era forebears believed could positively impact the world.

Design thinking is fundamentally incrementalist in its approach to solving problems (Halpern & Mason, 2015). This comes as a surprise to some who might assume that DT focuses on radical change, but in fact it relies on small iterative adjustments over time (Micheli et al., 2018). In this sense, design thinking is anti-revolutionary, as it presumes continuous adjustment as the means of innovating. This isn't to say that DT does not produce vast change, but its *modus operandi* is one of confirming positive changes with users in a methodical and affirming manner.

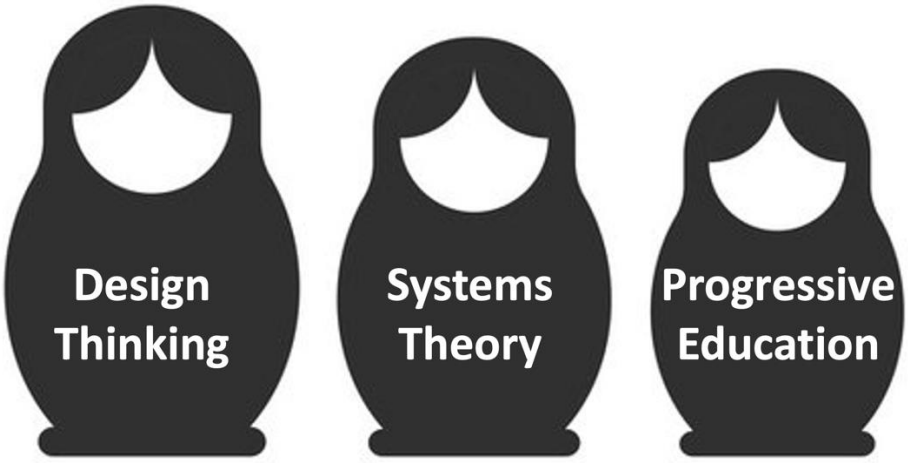
Conclusion

The researcher's theoretical view is to take Dewey seriously, by attempting to put into place systems, procedures, methods for problem solving, curriculum, and instructional practices which are *not* anti-traditionalist, but rather authentically and originally Progressive. Systems Theory allows those seeking institutional change to view the organization holistically, thereby hedging against implementation failure. Design thinking offers an opportunity to introduce a procedural method to inculcate innovation as the *de facto modus operandi* of our K-12 public education system to simultaneously (1) reform our education system to better match the needs of our

current time, (2) insert Progressive Education as a procedure, and (3) stave off the effects of institutional entropy.

Figure 8

Theoretical Framework as a Set of Russian Nesting Dolls



Note: Design Thinking, Systems Theory, and Progressive Education in relationship.

Chapter 3: Methodology

In this study, the researcher utilized a qualitative intrinsic case study design aligned to the approach outlined by Robert E. Stake to collect experiential perceptions, observe actions in the field, and review documentation related to the use of design thinking within a K-12 educational setting as a problem-solving methodology. This chapter will (a) describe the setting, (b) the selection of participants, (c) provide an overview of the research methodology and instrumentation, (d) discuss the threats to internal and external validity, (e) specify the analysis procedures, (f) address the limitations and generalizability of the study, and (g) review the steps taken to ensure the protection of human subjects.

Description of the Research Design

This intrinsic case study's design is modeled on Robert E. Stake's (1995) seminal text, *The Art of Case Study Research*. As such, the case study design, data gathering methodology, analysis of data, and validation of data all precede from Stake's epistemologically constructivist approach in an effort to accurately capture and describe this research.

Stake's Model

Stake posited that his approach to case study research is best utilized when seeking to study programs and people, and less well suited to event-based or process research. This recommendation is largely reflective of his view that a case is best viewed as an object of study that is specific, complex, and is functioning with working elements and a boundary that sets it apart from other adjacent cases (Stake, 1995).

From his stance, to uncover the workings and attributes of a given case, a qualitative research methodology is most appropriate, and should include four essential hallmarks: (a) a holistic view of the interconnected relationships of the phenomena being studied, (b) the

collection of empirical data from observations in the field, (c) a constructivist researcher-subject modality that is interpretive and includes the researcher's intuitive sense making, and (d) the lived experiences of the participants is conducted in an empathic and sensitive manner (Yazan, 2015). Additionally, Stake asserted that the case itself is of the highest importance, and so the path of the case study research cannot be overtly planned prior to field observations. Instead, the focus is on constructing insightful research questions that will guide the observations, interviews and document reviews as the research unfolds (Stake, 1995).

In a similarly flexible and open way, Stake claimed that data gathering does not have a definitive beginning point, and significant proportions of data gathered will be impressionistically and informally picked up as the researcher becomes increasingly familiar with the case. Although this perspective does suggest a loose approach, Stake clearly articulated that a data gathering plan with research and interview questions, identification of data sources, time allocations, and expenses are best determined prior to study. Where Stake is primarily focused is on the skill sets that researchers bring to the study that can be employed as the research unfolds (Stake, 1995). The essential skills he identifies are (a) knowing that which leads to significant understanding, (b) knowing what makes for good sources of data, (c) consistent testing of the accuracy and robustness of the researcher's interpretations, and (d) a requirement of sensitivity and skepticism (Yazan, 2015).

When analyzing data, Stake presented two strategies: (1) categorical aggregation and (2) direct interpretation. The direct interpretation of data is a striking feature of his approach, and is defined as the giving of meaning to first impressions and final assessments through the use of researcher intuition, as well as taking those intuitive impressions apart and further analyzing them (Stake, 1995). This intuitive approach puts "*the art"* in *The Art of Case Study*. With that

said, he recommends categorical aggregation methods for recognizing patterns in the data collection and analysis process as an equally essential part of his approach (Yazan, 2015). Linked to analysis, Stake offers four strategies of triangulation to validate data: (a) data source triangulation, (b) investigator triangulation, (c) theory triangulation, and/or (d) methodological triangulation. Overlaying these strategies, he encourages researchers to continually self-reflect if their analysis and intuitive interpretations are not only descriptively accurate, but also truly developing the right understanding of the case (Stake, 1995).

Application of Stake's Model to the Case

This study was closely modeled on Stake's recommendations, as it is focused on the qualitative observation of a specific group of people implementing a design thinking problem solving program to their professional practice. The qualitative nature of the research process was concentrated on the holistic, empirical, interpretive, and empathic aspects of case study design that centered the importance of the case itself. Although the researcher has taken Stake's charge seriously to collect and analyze data through skillful intuition, the importance of well-crafted research questions undergirded the case study design throughout. Lastly, this case study did break from some of Stake's conventions by planning interview questions, and developing templates for categorizing data collection and analysis, as supported by the complimentary constructivist case study methodology developed by Sharan Merriam (1998).

Setting

The research was conducted in a K-12 traditional public school district located in an adjacent suburb to the City of Philadelphia with a total population of 37,000 people. The district has approximately 4,500 students, 450 teachers, and 40 administrators. The district has a long history of being a welcoming and safe environment for religious and racial minority groups, and

as such is one of the most diverse districts in the Commonwealth of Pennsylvania. In addition to its racial and religious diversity, the district also serves students coming from a wide range of economic backgrounds, ranging from poverty to substantial wealth.

At the organizational level, the district spent several decades in a "holding pattern" with regard to institutional change, while neighboring districts engaged in continuous improvement efforts. In recent years, new leadership at the central office level has engaged in an effort of rapid institutional change by engaging in a wide range in initiatives, professional learning opportunities, and structural reorganizations. This process of rapid change has resulted in an acute need for a methodical approach to problem solving. Design thinking has been used by many at the leadership level to engage in this work, and as such the district is a prime site to conduct this research. The principal investigator is a member of the aforementioned leadership team in the district.

The use of design thinking to support institutional innovations primarily occurs within the Department of Innovation (DOI), a part of the broader Office of Education, operating out of the central administrative building. The Department of Innovation is led by several administrators overseeing a range of programs including, but not limited to: STEM, professional development, instructional technology, instructional data management, project based learning (PBL), and gifted education. The DOI also includes a team of teachers on special assignment operating in coaching roles around the use of innovative instructional practices and instructional technology. All members of the DOI have received training from the Stanford d.School's K-12 Lab on the use of design thinking. Not surprisingly then, the Department of Innovation operates as a kind of scaled down version of the Stanford d.School; the DOI guides schools and departments in the use of design thinking to help solve the complex, or wicked, problems they face.

One particular area of influence the Department of Innovation has that features as a central point of study in this research, is the development and ongoing support of a school-within-a-school Project Based Learning program. The PBL program is an opt-in course of study at the high school where students receive the majority of their instruction within a project-based paradigm. Students attend PBL as a large interdisciplinary block, with only mathematics and electives occurring in the traditional setting. Teachers are teamed by grade, with each teacher responsible for a core content area, but projects and instruction occurring in a de-siloed and interdisciplinary method, including classrooms with removable walls allowing for large group collaboration. The teachers and students have access to a fully kitted out STEM lab, with laser cutters, a CNC router, design and engineering software, professional level printers, power tools, and a host of other equipment and supplies necessary for project production. All teachers have attended a minimum of one week-long immersion experience at High Tech High in San Diego, the most prestigious PBL school in America, and they have received significant training in the use of design thinking from the Department of Innovation.

Participant Selection

This study comprised of two levels of unit analysis, as the research questions sought to learn about both education leaders, and teachers (Cresswell & Guetterman, 2019). The pool of potential candidates was narrowed to those who had previously completed a design thinking course through the Department of Innovation's professional learning offerings prior to the start of the study. This initial list of potential participants included central office and building based administrators, STEM teachers, gifted education teachers, instructional technology coaches, and project based learning teachers. The study's need to utilize individuals already trained in the use

of design thinking reduced the participant pool to a convenience sample, limiting the generalizability of results (Cresswell & Guetterman, 2019).

The participants were recruited through the researchers existing professional network, specifically those individuals with a relationship to the Department of Innovation's design thinking professional development sessions. The researcher made initial contact with the individuals within the participant pool using the email found in Appendix A. Individuals who responded in the affirmative to the email were further supplied with an informed consent form, as shown in Appendix B, and signatures were required prior to participation in the study. The researcher anticipated 5-10 participants. The final number of participants was 8, as determined by saturation (Cresswell & Guetterman, 2019).

Instruments

Following the guidance of Stake, the researcher crafted instruments to aid in the impressionistic, intuitive, and interpretive spirit of qualitative case study research by utilizing interviews, observations and document reviews as the modalities for data collection (Stake, 1995).

Interviews

Participants were interviewed during the first weeks of the study to gain insight into their current view of using DT in their professional practice. The questions, as seen in Appendix C, centered on the experiential nature of using DT, and how its implementation has impacted them professionally. Given the leadership role of the principal researcher, a possibility existed that participants may answer questions in a manner they perceive would impress the interviewer (Wong, 2015; Wong, 2018). To combat this potential manipulation, the researcher utilized a semi-structured approach developed to allow the conversations to deviate from the pre-

determined questions thereby allowing the participants to fully develop their thoughts (Barriball & While, 1994).

Observations

As the target of this research study is an evaluation of the case, observations were utilized to work toward greater understandings of the participants' actions with design thinking. The case demanded that observations of education leaders and teachers engaged in design thinking work be undertaken to better capture the nuanced experience of DT's application in real time. As such, good records were compiled (see Appendix D) of the observed meetings to generate a "relatively incontestable description" for later analysis (Stake, 1996. Pg. 62).

Document Review

Examination of reports, meeting minutes, empathy maps, brainstorming exercises, prototypes, lessons, units, project plans, and other design thinking produced documents was conducted. The researcher utilized a design thinking based notation framework (Appendix D) to capture findings in an organized manner, yet an intellectual position of openness was maintained "to accept unexpected clues" (Stake, 1996. Pg. 68).

Data Collection Procedures

This study's data gathering procedures were aligned to the recommendations of Robert E. Stake. As such, qualitative methods were employed to conjoin validation and accuracy with intuitive data collection (Stake, 1996).

Memo Process

Memos were used to capture researcher thoughts during and after each individual interview, field observation, and reviewed document. Memoing was undertaken to minimize bias through this reflective practice shown to aid in providing objectivity. Memos serve as a

metacognitive procedure to help separate researcher imposed theory, as opposed to allowing theory to emerge from the research (Birks & Mills, 2011). Memos included topics such as thoughts and concerns related to the study, interpretation of discussions, events and documents through a design thinking lens, reflections on the quality of data being collected, and notations on emerging codes, categories, and theories.

Triangulation

Data source Triangulation refers to the use of multiple data sources to check for accuracy and safeguard that researchers are drawing appropriate conclusions (LeCompte and Schensul, 2010), and as such interviews, observations and document reviews were conducted. Additionally, investigator triangulation was utilized by confirming recorded data with participants (see participant review below), and theory triangulation was used during analysis by viewing findings through the lenses of progressive education, systems theory, and design thinking (Stake, 1996).

Participant Review

Interview responses were recorded using audio recording devices, and following all interviews the researcher engaged in a process of memo writing. Transcripts and memos were shared with participants for their clarification, rejection, and/or agreement to ensure that interview findings were accurate. Following meeting observations, participants were provided with the organized notations that batched commentary by phase of design thinking, and again provided opportunity for clarification, rejection and/or agreement. Lastly, document reviews were conducted utilizing a similar organizational framework as the field observations, and authors and contributors to the document creation reviewed notations and provided feedback, rejection and/or agreement.

Analysis

The qualitative data analysis process was harmonized with Stake's assertion that data examination has to fit into the broader intuitive understandings of the researcher. The primary method to concretize the researcher's intuitive view was to see data through a design thinking lens, specifically by linking interview discussions, field observations, and document review data with phases of the DT process. This approach allowed for a deeper dive into DT implementation, as the actions and procedures of the different phases of DT vary significantly from one another. To better capture the data for proper analysis, (1) coding procedures were established and (2) theme identification was conducted.

Coding

The researcher used *in vivo* coding, a process of coding derived from words or short phrases using the participants' own words to capture categories of topics using participants' precise use of language following individual interviews and field observations To code the data, the researcher used a two-cycle method of coding (Saldaña, 2009). During first-cycle coding, the researcher used an *a priori* coding methodology whereby subcategories were initially used in alignment with the Eight Design Abilities of Creative Problem Solvers (Appendices D and E) (Creswell, 2012; Miles et al., 2014). During second-cycle coding, the researcher utilized an empirical coding methodology allowing for themes to emerge naturally from the words and phrases found in the data (Miles et al., 2014). The second-cycle codes then acted as further sub-categories within the initial *a priori* categories.

Identifying Themes

Using this information, I was able to look for specific themes and identification of within-case and cross-case themes that emerged from the data collection (Creswell, 2012; Yin &

Campbell, 2018). I also included direct quotes and passages from the participants, allowing for a more substantial representation of their voices and providing context to the findings. The coding categories allowed me to substantiate similarities or differences in knowledge of content area or disciplinary literacy strategies and skills among teachers and provide insight into areas of strength and areas of need regarding implementation, professional development, and training. To ensure reliability and validity, I supplied participants with transcripts of their interviews for member-checking (Creswell & Plano Clark, 2017).

Threats to Validity and Reliability

For the purposes of this study, the researcher utilized a qualitative intrinsic case study design to describe the experiences of those implementing design thinking as a problem solving methodology in a K-12 public education setting. As with any study, qualitative intrinsic case studies have threats to validity and reliability. Validity refers to the ability of instrumentation to measure what it purports to measure, while reliability refers to instrumentation consistency with regards to its measurement. This section will review the validity and reliability of the qualitative intrinsic case study methods employed in this study.

Validity

Validity refers to research *actually* measuring what researchers *believe* they are measuring. The use of design thinking as the notational framework for interview, field observations, and document reviews may impact findings by narrowing the focus of collectable data (Cresswell & Plano-Clark, 2017). To counter this concern, the intuitive approach, and the inclusion of informal impressionistic data collected holistically will be included alongside the notational frameworks and captured in notes and memos (Stake, 1996). The particular challenges and problems where design thinking was used to solve problems each represent a unique case.

As such, there is particularness to each of these individual cases, and so the experiences of the participants are largely wrapped up in individual unique problems; each new problem producing its own associated experiences, and thus drawing broad conclusions across this case may not always be appropriate. To resolve this issue, this study sought to describe the experiences of these specific implementers of design thinking, and not the experiences of all users of DT.

Stake's four triangulation methods were utilized in this study to bolster the internal validity of the collected data and the process of data analysis: (a) data source triangulation was utilized by collecting information from interviews, field observations and document reviews, (b) investigator triangulation was utilized by confirming notations and findings with participants and by collaborating with research peers and the dissertation chair , (c) theory triangulation was utilized when analyzing notations and memos by viewing findings through the progressively narrowing lenses of progressive education, systems theory, and design thinking, and (d) methodological triangulation by centering the study design on the Stake model, but incorporating aspects of Yin (2002) and Merriam (1998) when planning interview and field study notational frameworks (Yazan, 2016).

Positionality

The researcher is a practitioner of Design thinking, and as such has seen its ability to positively influence a team's creative confidence and production of innovative solutions to wicked problems. In the role of researcher, the researcher is positioned to see how DT is operationalized by others and its influence on their outcomes. This researcher/practitioner relationship also lays the groundwork for a potential intellectual conflict of interest. Although the researcher is intellectually and experientially positioned to recognize DT in operation, they must

be mindful to not insert its existence, success or influence when it is not explicitly identified by participants.

The researcher is also in a leadership position within the K-12 public education system. The researcher is committed to its long-term success, and as such is in search of systems, methods and actions that those in positions of authority can employ to better orient their institutions to the needs of 21st Century students. This leads to the need to engage in a process of mindfulness about their own background and professional role as they engage in observation, conversation, and data analysis.

Researcher Behavior and Bias

Researchers ought to maintain some distance from the study so as to ensure accurate observations. But nonetheless, results may succumb to the influence of researcher bias or misperceptions (Cresswell & Plano-Clark, 2017). As a design thinking practitioner and education leader, the researcher has an interest in the program's success, therefore data analysis was done utilizing triangulation and collaboration with the dissertation advisor so as to avoid interpretation bias.

Limitations and Generalizability

This study is situated within the context of one particular Philadelphia adjacent school district, and is not generalizable beyond the studied participants. Additionally, the small sample size of education leaders and teachers that participated in the case study also limits the degree to which the findings are generalizable to the larger population of K-12 design thinking practitioners. With regard to data collection, the modality of the study was limited to a qualitative intrinsic case study design, and so is limited by its lack of positivist and quantitative measures, thereby reducing the findings' ability to be generalized beyond the confines of this

case. Lastly, because the purposeful selection of participants for the study was limited to those with previous design thinking training and experience in application; interview responses, field observations, and document reviews are not generalizable to those seeking to establish design thinking as a new modality for problem solving.

Informed Consent and Protection of Human Subjects

Participants were provided with all necessary information regarding the study's purpose, methodology, and their specific role within the study. Following participant indication of interest in being part of the study, participants were given the opportunity to ask clarifying questions about the study and their role in the study in one-on-one discussions. Participants were given ample time to consider their consent within the study, to ask further questions, and to ensure that no undue pressure was on them to engage in the study. No exculpatory language, including the waiving of participant rights or the liability of the researcher, were included in the consent agreement (Appendix B). Documentation of all consent was recorded prior to the start of the study, and a copy of the signed consent form was provided to all participants

Confidentiality

Research documents produced for this study, including consent forms, interview recordings and transcripts, field observation notations and memos, and document review data were stored on a password-protected computer located in the researcher's home. Participants were deidentified throughout the data by assigning them a name-based pseudonym used throughout the course of the study. All data and other produced materials will be destroyed three years from the completion of this study.

Risks

It is possible that participant confidentiality could be lost, there could be a loss of privacy, and some individuals may experience a loss of free time during work hours or a loss of free time outside working hours. Some may experience discomfort with the content of interview questions, or experience mild anxiety when answering questions related to their professional experience. All reasonable measures were taken to alleviate these potential risks, including the option for participants to end their engagement in the study at any time, while recognizing that some risk of the above still remained.

Benefits

There was no direct benefit to participants for agreeing to engage in this research study. The data and analysis resulting from this study may help support those already engaged in, or considering the adoption of, adopting design thinking within the K-12 education sector as a methodology for solving complex problems.

Summary

This research studied the experience of a group of educators implementing design thinking as a problem-solving methodology. The educators were previously trained in the use of design thinking, and as such the focus of this research was on their application process, what it was like for them to use DT, what was seen when viewing their utilization of DT, and a review of the solutions and products the teams created as a result of this innovation procedures use. To study this, a qualitative intrinsic case study design aligned to the Robert E. Stake method was utilized. Data collection was done through individual interviews, field observations of teams utilizing DT in real time, and document reviews of products produced by design thinking.

Despite the limitations of this case study design, this methodology provided an in depth view of experience and impact of using design thinking to solve problems in a K-12 educational setting.

Chapter 4: Results

Through six interviews of teachers and administrators, six observed design thinking-centered collaboration sessions, and a review of five design thinking team crafted documents; this research study witnessed a variety of actions, processes, views, and examples of the Eight Design Abilities of Creative Problem Solvers (Stanford, 2020). This chapter is arranged by the Eight Design Abilities of Creative Problem Solvers, as they provided the architecture for the first round of *a priori* coding. The Eight Design Abilities of Creative Problem Solvers ordered within this chapters are: (1) Navigate Ambiguity, (2) Design Your Design Work, (3) Learn from Others, (4) Build and Craft Intentionally, (5) Synthesize Information, (6) Communicate Deliberately, (7) Move Between the Abstract and Concrete, and (8) Rapid Experimentation. Each design ability-aligned section is further divided into subsections aligned to the second-round empirical coding themes that emerged naturally. The field observations and document reviews provided the frame and structure to the collected data, while the interviews provide the voice for what was experienced by the participants.

Navigate Ambiguity

Navigating ambiguity is the bedrock of the design abilities, and is sometimes visually represented as spanning across all the other design abilities as the primary function of all design work. A designer must embrace the discomfort associated with “not knowing” in order to uncover and develop an innovative solution to a problem (Kelly, 2017). In addition to it relating to the comfort of living with uncertainty, it is also about using a toolbox of tactics to overcome ambiguity and lead toward clarity and solutions (d.School, 2019). Participants in this case: (a) recognized the emotional component of ambiguity as a part of the solution deriving process and (b) pointed toward those tactics and methodologies that worked for them to move through ambiguity toward clarity and understanding.

Managing the Experience of Not-Knowing

A large part of the ability to navigate ambiguity has little to do with the technical applications of design thinking, or the design abilities, but rather a mindset of openness combined with enough creative confidence to wade into the discomfort associated with the experience of ambiguity. As one teacher articulated, “There is always something new happening in the world, and it can be disconcerting to try to make your way through that” (Gracie, Interview). In this sense, he was pointing toward the ambiguity of the rapid pace of life and change in the 21st Century. He connected this directly to his work as a teacher within the Project Based Learning team when he went on to say, “I knew when I joined Project Based Learning that it was going to be dynamic on another level, and I can tell you the feeling is not a comfortable feeling, but it’s a good feeling. It’s not comfortable in the sense that you don’t have everything laid out for you, and so you know you will have to make your own path” (Gracie, Interview). This view of discomfort is an expression of what it is like for educators put into positions where they are tasked with innovation and problem solving. Another teacher, responsible for implementing innovative STEM experiences at the elementary level was commenting on his experience moving into a more innovative role, “I’m gonna [sic] put my wetsuit on and dive in” (Dutch, Interview). In some sense, this teacher is articulating an essential view held by all successful designers that engaging in that which is difficult is the only means to improve; as articulated by the Roman Emperor and Stoic Philosopher Marcus Aurelias, “The impediment to action advances the action. What stands in the way becomes the way.”

The Development of Creative Confidence

When discussions with participants turned toward the impact of their design thinking training on their ability to navigate ambiguity, a general sense of confidence emerged. Dutch

simply articulated how he developed capacity, “I have more confidence to be able to improve things now” (Dutch, Interview). Anne shared a more targeted articulation of this confidence, “[design thinking]…helps you visualize all of the abstractness in a more concrete way…It’s about being open to ambiguity which I think is really good, because it allows for serendipitous things and ideas to happen” (Anne, Interview). Tavener further supported this view through a growth mindset lens, and as an ability that can gain strength over time, “There is a much higher level of security, though there may be some angst amongst us as teachers understanding what we’re doing, but overall, we feel much more secure in how we are going to figure out what we will do next…in other words, you kind of build up a new muscle over time.” (Tavener, Interview). Tavener is articulating the unease experienced by those engaged in innovation juxtaposed to the confidence that is developed through repetition of the design thinking process over time.

Some participants described the direct connection to the use of protocols (explained and described in greater detail below) as a methodology to support the development of creative confidence when navigating ambiguity. One participant made clear that protocols allowed her to confidently innovate forward, even in the absence of solutions:

> I know that I’m very stuck on certain aspects of my project design, but what I like about the Charette and Tuning Protocols is that I’m comfortable with leaving aspects of my project blank, because I know that there are these colleagues that I will be working with that have ideas that will help guide me in those areas. I’m comfortable because it’s like the onus isn’t 100% on me to figure everything out. (Anne, Interview)

She is specifically calling out both the power of the protocols themselves and the impact of knowing she has a broader design team to collaborate with as a means to give her confidence as

she moves forward, and she is pointing to the inspirational impact of leaning on a larger support network when working though challenging problems. Similarly, another participant also identified the impact of protocols and collaboration on his creative confidence, “I have confidence, though, especially going through the protocols, and doing it not just in my own little world, but with a team and having them check my ideas. I think it allows for a lot of creativity and the ability to have a method to figure out what we are going to do” (Gracie, Interview). He is giving us a window into the effect of collaborative support when paired with a tightly-controlled design experience, and how that pairing produces confidence that there is a method available to foster problem solving. Overall, participants shared their experience of feeling anxiety when diving into ambiguous work, the confidence they feel when using design thinking as a tool, and the specific benefits of protocols and collaboration to provide them with the creative confidence and tools necessary to navigate ambiguity.

Design Your Design Work

The essence of “design your design work” is the idea of viewing the problems and challenges you face and driving them to become projects, because once it becomes a project the task becomes more manageable (Kelly, 2017). In a deeper sense, it is also about recognizing that the projects themselves are essentially design problems (d.School, 2019). In this case, the emergence of this design ability came through various participant ruminations, a clear focus on centering solutions end users, a repeated call for using design methodologies to solve problems, and ample examples of utilizing those methodologies throughout the study.

Participant Ruminations on Being Designers

Throughout the interviews a theme emerged indicating that the administrators and teachers did not only view themselves as educators, but also as designers. When speaking with one administrator, he discussed his curriculum writing work and the way he approaches it:

> I always refer to curriculum work as design work, and in that sense, I am a curriculum designer. Curriculum work needs to be designed, because there are so many parts to building it and it is ultimately used by teachers and experienced by students. So there needs to be a process to guide this along…I think the easiest way to do this is through design thinking, because it [design thinking] gives us a codified method. (O'Malley)

O'Malley's connection between curriculum writing and design work shows a clear indication that he is engaging in this work through a designer's eyes, and as such, is inserting design thinking into the process of building the student learning experience. Similarly, April described how a traditional teacher typically instructs in isolation, while seeking support from experts in the form of textbooks, and other previously created materials. In contrast, while teaching within a Project Based Learning structure, and utilizing design thinking, she explained how:

> I no longer think of planning as something that happens in isolation, or in a silo, and instead I see my colleagues as co-designers, even though the project I am asking for help with is only for my students, I know I have this team behind me that I can call on to think through how to develop the project…In some ways, I feel the project development process is almost like a different career where I am called upon to work with others to be creative and craft a student experience… now I think of my planning work as more intentional. (April)

Her description of planning for her students highlights how she has shifted her mindset to one of design - where collaboration is required, being creative is an essential skill, and intentionality is paramount. These excerpts highlight how working within the domain of design thinking recrafts the way that these educators think of their professional role when crafting student learning experiences. Specifically, they appear to have transformed from curriculum *deliverer* to curriculum *designer* and from project *planner* to project *designer*.

Designers Focus on the User Experience

Throughout the interviews, administrators and teachers referenced the importance of crafting the student experience. Nearly every interview featured a student-centered focus as part of their design work. For instance, Dutch started his conversation by saying that "designing experiences rather than delivering instruction has been a big shift for me, and that really aligns to design thinking in so many ways." He then connected this idea to some best practices aligned to curriculum design and other intellectuals in the design thinking space, particularly Jay McTighe, author of the curriculum designing text *Understand by Design*. Similarly, at one point during her interview, April exclaimed, "What experience am I trying to create?" when referencing her process for coming up with a new unit of instruction for her students. This again pointing back to the centrality of designing the user experience, as she views the student experience as preeminent, coming before student learning objectives, standardized assessments, or state-aligned scope and sequence documents.

Another participant explained what goes through his mind when thinking about the planning process for his students and ran through a list of questions that are at the top of his mind during the early phases of project design: "What is the intent of this project?

But…but…I think above all I wonder what is the overall experience going to be? Will they be working with their hands?...or pens?...or on the computer designing something?" (Travis). This focus expresses an interest on the part of the participant to center their own work around what their students will be doing, as opposed to required course standards, or what is assessed on standardized assessments. Instead, his design focus is on the modality of the experience where the learning will occur in order to center his further design work on the way students encounter the learning experience. Although different participants expressed the need to design for students in different ways, the emergent theme is around placing the user (student) at the forefront of their thinking.

Using Protocols to Design the Design Work

The use of protocols was found to be ubiquitous throughout the study, and as such were used as (1) a general tool to advance the design process, and (2) as specific tailored methods to achieve specific design goals. The specific methods used were (a) Empathy activities, (b) systems to define the problem, (c) Charette Protocols, (d) Tuning Protocols, (e) Design for an Extreme User, and (f) filtration devices.

The General Use of Protocols. Perhaps one of the primary findings from this case study was the pervasive use of protocols by those trained in design thinking. Within the field of design thinking, a protocol is a systematized way to guide collaborative work, discussion, critique and communication. Throughout the case, protocols were identified that had been borrowed and repurposed from other sources, as well as custom protocols designed for specific work by the participants. The example below (see Figure 2) is of a Charette Protocol, which participants modified for the purposes of developing student projects within the Project Based Learning setting:

Figure 9

Charette Protocol

Charette Protocol

The Charette Protocol was created to help develop roughly-formed projects into a more cohesive concept. It is best used after a teacher or team has formed a broad concept of what their project description is, and after identifying ideas for student deliverables.

Introduction (5 minutes) Facilitator briefly introduces protocol goals, guidelines, and schedule.

Presentation (5-10 minutes) The presenter begins with a broad description of the project concept and the deliverable product that would be the outcome of the student's work. This is not a time for questions, or interruptions, but is rather a dedicated presentation.

Clarifying Questions (3-5 minutes) Participants have an opportunity to ask clarifying questions in order to get information that may have been omitted during the presentation and would help them to better understand the work. Clarifying questions are matters of fact. Typically resulting in one-word responses. "What?", "Who?", and "Where?" questions. The facilitator is responsible for making sure that clarifying questions are really clarifying and not warm/cool feedback or suggestions in disguise.

Selecting Areas for Focused Support (5-30 minutes) The presenter selects three (3) core areas of focus for the supporting group to provide feedback. Each selected area is given 5 minutes for specific support. The team will brainstorm together ways to deepen, improve, or refine the targeted area to produce a more robust project. Some areas for focus: assessment, product, critique, essential questions, deliverable, ensuring equitable access, student interests and engagement, etc. It is a best practice to capture each idea on a sticky note and post in a viewable place so the team can build on each other's ideas.

Reflection (3-5 minutes) Presenter reflects on key takeaways, areas of growth and identification of items still needing further development.

Debrief (2-5 minutes) Facilitator works with team to talk through the process of the protocol, how effective the team was at supporting the presenter, and focusing on ways to improve during future protocols.

Note: The Charette Protocol is used mid-design to help move a Project-Based Learning project plan forward.

The essential components found throughout all of the protocols are clear instructions, relatively tight time restrictions, and dedicated time for reflection and debriefing. The development of protocols is an indication of their centrality to the practice of this case. In addition to the protocol above, participants developed protocols to: (a) help support brainstorming new project ideas, (b) refine well developed projects just prior to launching them to students, (c) meeting guides when seeking to improve administrative functionality, and (d) as a way to make better use of time during discussion meetings.

Additionally, throughout the interviews protocols were referenced as a go-to means to using a designed and crafted experience to guide the collaborative teams. One administrator was discussing the thought process he uses when a challenge or problem within the district emerges that requires an innovative solution, “My first thought is, is this a situation where we need to use some sort of protocol?” (O’Malley). Teachers made similar comments when working through their project creation process, such as when April noted, “When I notice that the project is mostly a reflection of my own ideas, I know it’s time to call for a protocol.” These comments pointed to the awareness of the participants to the need for a crafted experience to help move the design process forward. The teachers specifically called for a coming together of a design team to run through a protocol in order to advance their design process. In some sense, as designers, they recognized that when they reach an impasse in their project development, they blow into a proverbial horn to call forth a design team to put a protocol to work to help tackle the problem they are facing at that time.

The Specific Use of Protocols. Teachers and administrators used a wide variety of protocols to advance their design work. Some of the protocols were borrowed from design thinking sources, and others were internally developed to target their teams' specific needs.

Empathy Protocols. An empathy protocol is a direct pointing back to the design thinking process itself. Empathy protocols are used to learn more about the wants, needs and desires of end users of a designed product or experience. Throughout the study, participants referenced the need for, and used, protocols and techniques to foster the conditions necessary to better employ empathy strategies. Frequently, participants directly referenced the need to empathize (O'Malley, April, Dutch, Anne, Gracie, & Tavener), and a common practice was to include end users in the design process itself; perhaps most notably the inclusion of students in the project design process and as collaborators during project protocols, as referenced during most teacher interviews (O'Malley, Anne, Gracie, and Tavener).

The participants utilized specific empathy protocols throughout the study. When central office administrators were designing a new student data management system for principals and teachers, they conducted empathy interviews with some individuals who would be using the new system in the future. The interviews were centered on asking questions about their thoughts and feelings with the current data management system, and their responses were recorded on an empathy interview graphic organizer that guided the notetaker into four categories: (a) "they said", (b) "they feel", (c) "they did (body language)", and (d) "they inquired" (Data Management, Observation; Data Management, Document). Similarly, in an observed administrator meeting, participants used a guided empathy process to gain deeper insights into the needs of a department that was preparing to hire a new team member by using a series of predetermined questions that dug deeper and deeper into the real wishes and desires of the team

members (New Hiring Protocol, Observation; New Hiring Protocol, Document). Overall, the participants sought out, and used, methods to specifically elicit empathy data as an early step in their design work.

Defining the Problem. The define stage is a specific step within the design thinking process that seeks to collect, organize, and ultimately summarize the findings derived from the data collected during the empathy phase. The participants' use of protocols to synthesize empathy information is discussed in greater detail later in this chapter, under the heading *Synthesize Information*, but it is noteworthy here as a process that was specifically designed into the problem-solving process in deliberate ways. Specifically, two methods were employed throughout the study: (1) Point-of-View statements that guide designers through a fill-in-the-blank sentence structure that helps summarize what was learned during the empathy phase, and (2) How Might We? statements that push the designers beyond simple summarization to deeper insights and hypothesis statements for later development.

Charette Protocols. The most commonly referenced use of protocols during the case study were Charette Protocols. An example of a modified Charette Protocol can be found above (see Figure 9). Their primary purpose is as a mid-way support system for those utilizing design thinking to solve a problem. The Charette Protocol presumes that the core design team completed the empathy and define phases , and that a rough prototype of a final solution is mocked up in some way. The core design team is then seeking a broader collaboration experience with fellow colleagues, not intimately versed with the problem, to provide further brainstorming, support, and guidance. The original core team is then able to take the Charette Protocol findings back to their proverbial drawing board to further refine their solution prior to further prototyping.

Participant interviews indicated that from their point of view the primary function of the Charette Protocol was as a methodology to help get the design process unstuck, or moving again, after initial solution making had ceased to make further gains. As one participant put it, "When I notice that the project is mostly a reflection of my own ideas, I know it's time to call for a protocol" (April, Interview). This points to a common problem in design work, namely doing too much individual work without input from design colleagues or end users. This participant is cognizant of when her work needs a boost, and to do this a Charette Protocol is invoked. Similarly, during Anne's interview she provided an in-depth view of the use of Charette Protocols that seconds the power of Charette Protocols to help move the design process along when mired mid-stream:

> The Charette [Protocol] allows for people to give their input and to give perspectives that you would not have considered before…and other people will interpret your idea in different ways that are 10,000 times better than what you had originally thought of…[and] I do like the method of getting other people's ideas, because it allows for you to get new perspectives. You also come to see your project in a new way when other content area teachers, and especially when students, … [are] involved in the Charette [Protocol].

Anne's insights on what it is like to use the Charette Protocol is an indication of the desire on the part of participants to use the methodology to design a crafted experience that draws out new ideas and alternative perspectives on their work. Throughout the study, every teacher participant referenced the importance of Charette Protocols (O'Malley, April, Dutch, Anne, Gracie, and Tavener), they were observed to be well executed when observed (9^{th} grade, Charette Observation; 11^{th} grade, Charette Observation) and the teaching team had modified an existing

generalized Charette Protocol into a targeted version specifically tuned to the needs of their larger team (Charette Protocol, Document). Charette Protocols were observed helping teams move their design process forward, and the participants frequent calls to use this methodology spoke to their centrality in this case study.

Tuning Protocol. Similar to the Charette Protocol, participants frequently referenced the Tuning Protocol throughout the case study. Where the Tuning Protocol differs from the Charette Protocol, is that it is used during a later, or more refined, part of the design process. The Tuning Protocol was referenced as a final large scale collaboration event prior to a live launch of the solution "into the world" (Tavener, Interview). As the name indicates, it is there to tighten loose design elements and offer the design team a final outsider's view of the solution they have crafted.

The Tuning Protocol itself unfolds in a similar manner to the Charette Protocol; however, its key feature is how the team discusses the proposed solution. Following the presentation of the proposed solution and clarifying questions phases, the core design team is asked to step away from the larger collaboration team. They take a seat outside the circle, and their role is to silently take notes on the discussion that unfolds before them. Meanwhile, the remainder of the collaboration team engages in a guided conversation where they first offer "warm feedback" about elements of the proposed solution that are favorable prior to engaging in "cool feedback" where concerns, unresolved questions, outsider perspectives, perceived challenges, and other critical feedback is discussed. Following this phase of the protocol the core design team is reinvited to the larger group where they reflect on what they heard, ask follow up questions, and then debrief on their overall experience (Tuning Protocol, Document).

Teachers utilized Tuning Protocols prior to launching their projects to students (9th Grade Tuning Protocol, Observation; 11th Grade Tuning Protocol, Observation). When discussing the use of tuning protocols, participants largely referenced them as a foregone conclusion as part of their presumed process of project development, such as "…which I try to finish before we do a Tuning Protocol" (Tavener, Interview), "…and I will wait until after the Tuning Protocol to actually make my rubrics, because things always change" (Anne, Interview), and "I know my project will continue to shift until after the Tuning Protocol" (Gracie, Interview). The presumed use of Tuning Protocols as a final step in the design process is a further indication of ways that protocols are used to design their design work.

Design for an Extreme User. The "Design for an Extreme User" process was observed as a guided methodology to brainstorm a range of potential solutions to a problem. In this observation, the focus was on developing solutions for classroom culture challenges faced by the Project Based Learning teams; specifically, students who were not "bought in" to the idea of PBL. The room was organized by PBL teacher teams, and the session was led by an administrator. Participants were asked to identify a single student in their classrooms who represented the most "extreme" example of a disengaged student. They were then guided through a series of questions that prodded the teams to consider projects, routines, and other methods that may reach and improve the engagement level of their student. Once teams centered on their best possible solution, they thought about a wider and broader application of their solution to their entire student body. The driving theory behind this protocol was to hyper focus the attention of the design teams on one extreme user, but in the end they were guided to apply this solution to the entire group. The teams received this guided protocol enthusiastically, and their discussions ultimately centered on how their ideas to impact the identified student had applicability to a

wider audience (Design for an Extreme User, Observation). Using the Design for an Extreme User method to seek solutions is a prime example of designing the design work, as in this case they were essentially engaged in a focused brainstorming activity. By capturing the work within the Design for an Extreme User modality, it guided their creativity in a predetermined way that allowed for focused ideation.

Filtration Devices. A filtration device is a method designers use to hone down a large set of ideas, or potential solutions, into a single narrow concept that will be the focus for further development, prototyping, and revision. Filtration devices stand apart from protocols in that they are applied when needed, as opposed to being a predetermined protocol.

For example, during one observed meeting the team used the Point-of-View statement developed prior to brainstorming to act as a kind of judge for potential solutions. Each idea developed during the brainstorming phase was written on a sticky note that was placed on a white board. During the filtering process, each sticky note was moved adjacent to the point-of-view statement to determine if it qualified for further consideration. Those that did, were moved to the side, and those that did not were removed from the white board (Data Management, Observation).

Similarly, following the brainstorming phase of another observed meeting each team member was allotted three red stickers, three green stickers, and three yellow stickers. Each sticker would represent a “vote” where red represents ideas that would be game changing, green stickers represented ideas with a high probability of success, and yellow stickers represented ideas that were already being utilized, obvious, or considered best practice. The team members placed their votes directly on each sticky note on the whiteboard. Sticky notes with no votes, or only yellow votes were removed from the board, leaving only game changing and likely to

succeed ideas for further consideration (Hiring Procedure, Observation). The use of these filtering devices is a further indication of the participants' employment of methods to craft and design an innovation producing experience.

Learn From Others

Learning from others is a call to transcend the habit of going back to one's desk and trying to resolve problems on your own, and to offer an alternative to the belief that you just need to work harder. For design thinking to work, designers must get over their fear of talking to others, and to recognize that we learn from other people who often offer better ideas (Kelly, 2017). It is also about embracing diverse viewpoints, and testing ideas not only with end-users but also with other stakeholders and colleagues (d.School, 2019). Throughout this study, themes of working with others emerged that centered on: (a) empathizing with others, and (b) engaging in collaboration, and (c) utilizing specific methods that foster ideation and cross pollination of ideas.

Empathize

Within the broader frame of "Learn from Others", the targeted approach of Empathy emerged in the research spanning across interviews, observations, and documentation. Although the Empathy phase is a discrete approach found in nearly every design thinking model, it also appears in this case study as a learned approach being broadly and precisely applied. The presence of Empathy as a guiding philosophical approach was expressed in O'Malley's interview, where he was speaking from a Central Office administrator's lens about his approach to tackling the issues and challenges that emerge in his role:

> When problem solving, we have somebody that we are designing for…typically a student, family, teacher or administrator. The intentionality behind our problem

> solving work is to target the end user and direct our work to design for their interests.

This part of the conversation showcases the impact that design thinking has had on this administrator's thoughts about the focal point for designing solutions and is a direct pointing back to the design thinking process itself. This need to place the end user at the front of the problem-solving process was echoed by Dutch when discussing the process he went through in developing a STEM program in the elementary grades that required teachers to give up much needed instructional time to give students an opportunity to engage in makerspace and STEM experiences:

> I made sure to include teachers in the planning, and we went to each teacher to explain 'here's what we want to do'. We sought out the teachers' feedback and concerns to be sure that every member of the learning community's voice was heard. We knew that if we didn't meet the needs and have the buy-in of 100% of the staff, whatever plan we developed would not work.

This focus on buy-in and meeting a specific interest group's needs up front, prior to the specific design of the program, was a call to action for Empathy work. By placing the needs of one of the school community's users up front, and specifically a group for whom the success or failure of the new program would depend, allowed him to design solutions that he could feel confident would not later result in push back resulting in less program success.

Further use of Empathy as a means to "Learn from Others" was observed directly in several team meetings (School Improvement Plan; Hiring Procedure). The team responsible for developing a new data protocol system for the district at large employed an Empathy protocol where they engaged in one-on-one interviews with building principals. During those

conversations the central office team members utilized a common design thinking empathy note taking graphic organizer called “think, feel, emote, wonder”. As they spoke with principals about their own personal use of data and their school’s overall use of data, they take notes under those four categories to connect the ideas of the principal back to their intuitive thoughts and feelings. The team then debriefed what the principals told them in their interviews using these headings to categorize and organize the findings (School Improvement Plan).

Another administrative team that developed a new hiring procedure for administrators began their work by engaging in a self-Empathy protocol where they used guiding questions to get at the practical, but also deeper needs of the team when seeking out new candidates. The protocol was guided by a design thinking practice book, and featured the use of sticky notes that each represented a specific need. This procedure organically moved in and out of empathy and synthesis but was always brought back to center on the needs of the team, district, schools and students in order to create a conceptual map of what needs would need to be designed for when reconsidering how administrators are hired (Hiring Procedure).

Overall, this case study demonstrated a blending of theoretical understandings regarding the importance of Empathy work, and observable actions that highlight Empathy in action. Together these seem to indicate that design thinking has directly impacted the team members’ ability and willingness to use Empathy as a methodology to “Learn from Others”.

The Experience of Collaboration

The emphasis on the importance of collaboration came through in the participant interviews as one participant succinctly summarized, “…more minds are better than one (Tavener, Interview)”. In all interviews and observations, it was clear that collaboration between those versed in design thinking was welcomed, and enthusiastically supported. Tavener again

laconically summarized his experience, “I think the collaborative process has been beneficial in the sense that I have so many colleagues who are willing to provide feedback…” (Tavener, Interview). Anne provided a more colorful sketch of why her experience with collaboration has been successful:

> …[when] you present [your project ideas] to students or colleagues who have had different experiences, and they say ‘yes’ or ‘yes, but’ or ‘no’; you get a whole new perspective…you also get to flesh out all your fuzzy ideas that aren’t clear…and it takes a little bit of burden off of you because you’re coming together with all these other minds, and you know that they’re invested and want to make your experience as awesome as possible. (Anne, Interview)

In this example, she identified the connection between learning from others as a means to clarify her own work and the power of knowing she is a part of a larger team of collaborators who want to see her be successful.

Other participants focused more directly on how the act of collaboration is an absolute necessity to developing one’s craft professionally, and as a designer. One participant discussed his experience in moving from a more traditional teaching setting into a lead innovator role, and how that has shaped how he approaches his own professional practice, “I have learned to seek out more knowledge, more information, more ideas, and to connect with people who know more and different things than I do…It literally does not make any sense to me how someone can close their door and just do their thing for 30 years without collaborating” (Dutch, Interview). He recognized the power of collaboration on his craft, and as such he is referencing the impact it can have on anyone.

Perhaps most poignantly, Tavener, who engages in a wide variety of other highly-skilled tasks and endeavors outside of their professional practice, had a very focused view on what it means to engage in collaboration professionally:

> You don't have much of an opportunity to learn from other teachers that are better than you until you are collaborating with them…I don't care what your profession is. If you want to be better, you put yourself with people who are better than you. (Tavener, Interview)

With this comment, Tavener linked the ability to be better at what you do directly to collaborating with those more skilled than oneself. In this sense, it is the process of learning from others that enables that growth to occur, and for more skilled problem solving to develop over time.

The Role of Design Thinking Methodologies to Provide Quality Control

There is a direct link between the role that DT methodologies, and specifically protocols, play in fostering opportunities to learn from one another. As has been referenced previously, every participant in the study referenced the power of protocols and methodologies to engage them with colleagues in collaborative creativity. The same methodologies and protocols described in Design Your Design Work are present when thinking about learning from others, namely: The 50 Projects Protocol, Charette Protocol, Tuning Protocol, and Design for an Extreme User, as well as observed moments of brainstorming throughout the study. What is of specific interest to the topic of learning from others is the particular ways that these systems foster moments of successful collaboration that is targeted and designed to move the design process forward.

The protocols themselves remove the ambiguity and amorphousness of unstructured collaboration by providing (1) clear instructions, (2) appointing a facilitator, and (3) requiring time limits which all appear to act as quality control measures during observed meetings. For example, within the Charette Protocol directions participants are instructed to engage in brainstorming with the following guidelines:

(1) Our emphasis is on volume of ideas, not refinement – Give an idea, and move on.
(2) Do not immediately respond to an idea.
(3) Do not debate, critique or engage in prolonged discussion about a proposed idea.
(4) You may say "yes...and" prior to providing additional supporting ideas.
(5) Each idea will be captured on a sticky note and displayed for others to see.

These directions provide those engaging in collaboration with guardrails on how to engage with one another while brainstorming. The emphasis on a rule-based approach, combined with a time limit, resulted in focused and on-task behavior throughout both observed Charette Protocols, as well as the observed Hiring Procedure and Data Management meetings guided by similar brainstorming rules. Additionally, the role of the facilitator was essential. In two observed meetings, the facilitator stepped in during brainstorming to: (1) remind participants to keep idea debate to a minimum and to focus on ideating more ideas (9^{th} Grade Charette, Observation) and (2) to cut off a conversation about an idea that was a project recommendation in the disguise of a clarifying question (11^{th} Grade Charette, Observation). The overall observed effect of the protocol rules and regulations was to produce highly effective collaboration that was valued by the presenting teams, as referenced during their reflections (9^{th} Grade Charette, Observation; 11^{th}

Grade Charette, Observation; 9th Grade Tuning Protocol, Observation; 11th Grade Tuning Protocol, Observation).

Build and Craft Intentionally

Build and Craft Intentionally is all about designing something for others to see, use and interact with (Kelly, 2017). At its core, this design ability is about thoughtful construction of things and experiences (d.School, 2019). Throughout this study participants: (1) emphasized the centrality and importance of the user experience and (2) engaged in iterative work that could be repeatedly presented to their end users.

User Centricity

Some participants revealed a theoretical view that centered the development of design work around the needs of their users. For instance, one administrator referenced this directly when discussing the development of a third-grade mathematics curriculum:

> I like to think of what I do through a user experience lens…so in terms of curriculum design, I'm not the one teaching that curriculum, right? So, I might create a curriculum that makes sense to me, but that work would be done before the teachers have even seen it. It's every third-grade teacher I need to think about…I need to think about the teacher and their students as the end users of that product…so I have to intentionally craft, I have to relate what I do to the end user, which is all from a design thinking standpoint. (O'Malley, Interview)

He is clearly articulating the need to remove his own biases and perspectives from the curriculum design process and purposefully and intentionally inserting the user into that space within his design process.

Similarly, a teacher within the Project Based Learning program pointed directly toward his students as the aim of his design work, and some methods he employs to make that connection authentic: “In Project Based Learning we have this emphasis on bringing the student into the process of curriculum (project) design as early as possible, and into the decision-making process on what products they are going to be asked to create.” (Gracie, Interview). In this example, the teacher employing DT principles is actively including students in his procedures to ensure that their voice is heard throughout the project development process. By including students in the process, he is giving them voice and choice in what project they are going to experience, what kinds of products they will be asked to create, how they will be assessed, and what timelines will be created. This student-centered approach enables the teacher to avoid making decisions that the students will later overtly or silently reject, thereby reducing buy-in, cognitive engagement, and overall learning.

Iteration by Design

Participants in the case study utilized various methods of producing iterative versions of their work to be able to display and share with others at targeted times in order to receive user feedback for the purposes of further refinement. The teachers in the Project Based Learning program had developed a three-tiered system when employing their predesigned protocols. The first layer of this work was their use of the 50 Projects Protocol, which they use when trying to explore a wide range of potential projects that aligns to their curricular needs (50 Projects Protocol, Document). Following this protocol, the grade team will develop a rough sketch of what they want their project to be, what it would look like for students, and in what areas of support they need help. They present this iteration of their project to the wider PBL team during a Charette Protocol, where their sketch of an idea is brainstormed and provided with enrichment,

critique, and suggestions for moving forward (Charette Protocol, Document). The team again further refines their project, and once again presents a more complete picture of their project to the wider PBL team during the Tuning Protocol, where they receive more refined and targeted feedback from colleagues and students (Tuning Protocol, Document). This iterative process of creation, critique and revision is built into the fabric of the Project Based Learning program's design methodology.

Administrators developing a new data management procedure engaged in a brainstorming and idea development process. The brainstorming work eventually led to a prototype "School Improvement Plan" which was first shared with two identified principals with the highest data usage proficiency. Their feedback produced a revised version which was then reshared with them the following day, revised again, and shared with the remaining district principals who provided further feedback. It was then revised a final time and shared with all principals. Finally, the completed live version was produced and shared that included a few additional recommendations (Data Management, Observation; Data Management, Document). The participants involvement of the end user directly into the feedback and iteration process showcases building and crafting intentionally as an essential design skill.

Synthesize Information

Within a design thinking framework, Synthesis is all about pulling together everything that has been learned and distilling it down to an essential core understanding that can be leveraged to further the design work. Design thinking specifically seeks to tease out insights and opportunities as part of its synthesis process (d.School, 2019). Developing the ability to synthesize information is essential as data comes from many places and has qualitative and quantitative forms. Designers leverage frameworks, mental maps, and abductive reasoning as

methods to better understand their users and design challenges (Menguc, Auh, & Yannopoulous, 2014; Filippetti, 2011).

Encouraging Synthesis by Way of Protocols

Protocols acted as a method by which synthesis was fostered and encouraged throughout the study. Protocols were found to enable synthesis to occur through two primary functions: (1) through activities allowing for the manipulation and recategorization of data, ideas and concepts and (2) through filtration devices.

Synthesis Activities. The 50 projects, Charette, Tuning, and Design for an Extreme User protocols all contained directions producing synthesis. The directions given by the facilitator during the observed Design for an Extreme User protocol are a good example of a synthesis activity in action. There were two layers of directions given, starting with "silently brainstorm ideas that would help your extreme user. For each idea, write it on a sticky note, and place the sticky note on your team's whiteboard." After a pre-determined amount of time, these directions were followed by: "Working together, move your team's sticky notes into logical categories, then use a whiteboard marker to circle and name the topics that emerge." These directions move the team beyond simple brainstorming into a process of synthesis through discussion as the team has to put their ideas together and determine what commonalities have emerged. These directions helped the teams move from a wide range of seemingly disparate ideas toward a condensed block of concepts ripe for further development. Nearly identical procedures were observed during other observations (Hiring Procedure, Observation; Data Management, Observation, 50 Projects Protocol, Observation). Similarly, other conceptually similar activities were built into the other protocols (Charette Protocol, Document; Tuning Protocol, Document).

Filtration Devices. Although filtration devices are described in detail above (Design your Design Work), they are also of note here for their role in producing synthesis. The specific aspect of filtration devices in synthesis is their role in guiding the team through the broad array of ideas and possibilities developed through either (1) the empathy phase of the design thinking process or (2) following an ideation/brainstorming protocol, and toward a concentrated understanding of what will be the design work moving forward.

Filtration Devices to Synthesize Empathy Data. The two methods observed during the case to synthesize empathy data were "Point-of-View" (POV) statements and "How Might We?" statements. The POV statement is a fill-in-the-blank sentence that typically reads:

> _____ (identify the user) needs a way to _____ (deep insight discovered during Empathy phase) but/however/considering _____ (define the core problem). (Brown, 2018)

The team then distills everything learned during the Empathy phase by completing this sentence, for example when synthesizing the empathy data for a new data management system to be used by principals, the team developed the following slightly modified POV statement, "Principals need a way to authentically use data to act." This process was observed on two occasions (Hiring Procedure, Observation; Data Management; Observation).

The "How Might We?" approach is a more open-ended process by which the team derives a single question to help move the design process forward. During the Design for an Extreme User observation each team derived their own, for example one team wrote "How might we make boredom a skill?" Both are classic examples of define stage design thinking practices that seek to land on a single statement the design team will use throughout their process to clarify

what their user's needs and insights were found to be and express a clear ability on the part of the participants to synthesize information.

Filtration Devices to Move Beyond Brainstorming. Participants used filtration devices to move the design process past the point of having produced many potential solutions, down to a few ideas that could be further explored for more serious development. As described above (Design your Design Work), the method of giving participants a vote on those ideas that accomplish specific goals was a way to filter down from dozens of ideas to three or four leading contenders (Hiring Procedure, Observation). Another method was to employ a commonly-used design thinking filter that seeks to identify the "sweet spot" of innovative ideas. It asks the team consider the idea's (a) feasibility, (b) desirability, and (c) viability. A winning idea is one that meets all three of these ideas (Orton, 2017). The 50 Projects Protocol observed in this case utilized both filtration devices, as the protocol itself is primarily a brainstorming activity. Following a guided, but largely freewheeling brainstorming session, the team reviews all the ideas and places their votes on the ideas they believe would be (1) game changing for students, (2) produce deep levels of learning, and/or (3) extract an emotional response. Following this voting phase, half-a-dozen ideas held potential. The feasibility, desirability and viability method was then used to determine which of the remaining ideas was the best for further development (50 Projects Protocol, Observation).

Encouraging Synthesis Through Designed Discussion

The study indicated that participants frequently used discussion as a means to synthesize information. Discussion deriving synthesis occurred organically in all observed meetings. Although synthesis was present in these cases, it could not be directly tied to the participants' use of, or training in, design thinking. As such, organic synthesis by way of discussion is not

considered an example of a design ability by the researcher, even though it was present in all observations.

Synthesis derived through guided discussion, or as part of a protocol, however, does indicate a design ability on the part of participants. This was seen in the development and inclusion of guided discussions throughout the protocols and activities of the case. In all of the protocols guided discussions made way for synthesis, like in the Tuning Protocol when the team is asked to engage in discussion where they summarize their praise and critiques of the project proposed to them in the form of "warm and cool feedback". This process not only helped each participant synthesize their thoughts about the project presented to them, but also the presenting team when they later discussed their core takeaways from the discussion. Similarly-designed procedures were embedded into all of the protocols (50 Projects Protocol, Document; Charette Protocol, Document; Tuning Protocol, Document).

Communicate Deliberately

The ability to engage in deliberate communication is an essential design skill, and is critical to a project's success (Kelly, 2018). It is also the ability to form, capture and relate one's ideas about their design work to others, and to do so in such a way that it moves the design process forward (d.School, 2019). This case study witnessed participants engaging in deliberate communication through (1) guided discussions, (2) guided questioning, (3) guided reflection and (4) guided debriefs. In addition to these four expressions of deliberate communication, the Project Based Learning teachers also indicated that their approach to communicating with students was altered as a result of their design thinking perspective.

Communicating Deliberately Through Guided Discussion

The 50 Projects, Charette and Tuning Protocols all contained planned guided discussions as part of their required procedure as a means to foster communication around a specific aim or goal. Additionally, all of the protocols also identified a facilitator with specific tasks to keep discussion centered and on track for the purposes of that particular protocol. For example, the 50 Projects Protocol, a brainstorming/ideation experience designed to generate ideas, requests that participants focus on "quantity over quality", and charges the facilitator to cut off discussions which begin to center around a specific idea, and thereby slow down the rate of new idea creation (50 Projects Protocol, Document). Similarly, the Charette Protocol, designed to help improve an idea that is only partially developed forces the discussion to center around 3 topics selected by the design team, and the facilitator is charged with keeping the conversation bound by a single topic during its allotted time (Charette Protocol, Document). Lastly, the Tuning Protocol has participants provide praise and critique of the project presented to them, while charging the facilitator with the requirement to keep their commentary focused on the project as presented and to minimize negative feedback that is not aimed at helping foster revision and improvement (Tuning Protocol, Document).

Communicating Deliberately Through Guided Questioning

The use of a question-and-answer session between designers that is guided was observed as a way that design helps foster targeted and focused discussion. For example, the Charette Protocol has a phase that occurs after the initial presentation of the burgeoning project idea named the "Clarifying Questions" phase. The directions for participants are:

- "Participants have an opportunity to ask clarifying questions in order to get information that may have been omitted during the presentation and would help them to better understand the work.
- Clarifying questions are matters of fact. Typically resulting in one-word responses; "What?", "Who?", and "Where?" questions
- The facilitator is responsible for making sure that clarifying questions are really clarifying and not warm/cool feedback or suggestions." (Charette Protocol, Document)

During a Charette Protocol observation, participants followed the instructions, and when they veered toward too much elaboration, or in one case a suggestion in the form of a question stem saying "Have you considered…", the facilitator stepped in to keep the guided question portion of the protocol in adherence to the instructions. The result was a very focused conversation about the particular details of the presented project that were not described in the initial presentation, but that the designers had none-the-less considered (9th Grade Charette Protocol, Observation).

The Tuning Protocol also contains a clarifying questions phase, but then includes a deeper dive into the project idea during the "Probing Questions" phase. Immediately following the clarifying questions, the probing questions directions were:

- "Probing questions center on gaining more insight into the speakers' thoughts and intentions without providing suggestions or recommendations.
- Probing questions <u>do not</u> sound like "have you considered"…"what if"..."Maybe you could…"

- Probing questions do sound like “How do you plan to….” “Why does this project…”
- “How?” and “Why?” questions.” (Tuning Protocol, Document)

During an observed Tuning Protocol, the shift from clarifying questions to probing questions was clear, as the participants dug in deeper into the mindset of those proposing the student project. One collaborator asked, “considering that different groups of students will be taking on different tasks during the production of the play, how do you plan to use the rubric you shared for all the students?”, while another asked “How will students have an opportunity to get feedback on the play prior to opening night?”. In this case, the facilitator was not required to keep the team aligned to the probing questions phase, as they adhered to the requirements. The result was a focused discussion that drew out deeper insights and thoughts the project designers had, but it did not veer into either elaborated tangential conversations, or recommendations masquerading as questions. The overall effect of the guided questioning phases of the observed protocols was to hone in and target collaborative discussion on specific elements of the design process that allowed those designing to better articulate their ideas and to expose any potential areas in need of further development.

Communicating Deliberately Through Guided Reflections

In every procedural document collected (50 Projects Protocol, Document; Charette Protocol, Document; Tuning Protocol, Document) and in all observed meetings (10th Grade 50 Projects Protocol, Observation; 9th Grade Charette Protocol, Observation; 11th Grade Charette Protocol, Observation; 9th Grade Tuning Protocol, Observation; 11th Grade Tuning Protocol, Observation; Design for an Extreme User, Observation; Hiring Procedure, Observation; Data Management, Observation) the specified use of a reflection process was used. In all cases, the

purpose of the reflection process was for the designers to review (1) the most salient ideas, recommendations, and insights they were taking away from the process, and (2) to share their next steps and what support they will need moving forward. Although the process of reflection could be seen as a simple capstone exercise, it serves the essential function of (1) requiring the lead design team to summarize their learnings, and (2) to communicate to the broader design team the impact that their collaboration, insights and support had on the lead design team. This form of deliberate communication was crucial in the role of clarifying the impact and importance of the design work the teams engaged in.

Communicating Deliberately Through Guided Debrief

In every procedural document collected (50 Projects Protocol, Document; Charette Protocol, Document; Tuning Protocol, Document) and in all observed meetings (10th Grade 50 Projects Protocol, Observation; 9th Grade Charette Protocol, Observation; 11th Grade Charette Protocol, Observation; 9th Grade Tuning Protocol, Observation; 11th Grade Tuning Protocol, Observation; Design for an Extreme User, Observation; Hiring Procedure, Observation; Data Management, Observation) the specified use of a guided debrief was used.

The purpose of the debrief stood in contrast to the reflection process. Where reflection was for the purposes of reviewing the impact of the design process, the debrief was used to specifically take a step away from the particular problem/project being designed to review how the design experience unfolded, and what improvements could be made. Following a Charette Protocol, an administrator said, “There are so many talented folks at the table, but I feel like we only heard from about half of you. I would love to hear from everyone on the Tuning Protocol we are about to start for the other team” (11th Grade Charette, Observation). This call for greater participation was enabled by the protocol itself which asked the participants to reflect in this

way. During another Charette Protocol a teacher suggested that “we seem to always get bogged down a little during clarifying questions, I think 10 minutes may be too many…maybe 5 or 7 minutes is enough” (9th Grade Charette, Observation). In the same observation another teacher mentioned that “the presentation was a little brief, and there wasn’t a one sheeter [project summary] for us to review. I think our Charette’s seem to go better when we have something to look at.” Similar commentary was observed in other meetings during the debrief segment, and their overall function was to operate as a kind of design thinking procedural quality control; using gentle peer pressure to keep the quality of the protocols high. This functionality was deliberately inserted into the design process, and acted as an effective system of collaborative metanalysis by way of communication.

Participant Ruminations on Design Thinking Inspired Communication with Students

During participant interviews a theme emerged around the impacts that the teachers’ communication style had on their Project Based Learning students. Many of them juxtaposed this directly with their students who were not in PBL courses, for example Gracie said “My PBL students have come to expect me to be more of a facilitator, whereas my other classes look to me to be the dispensation center for knowledge. That’s not the case with PBL, I think they expect for it [learning] to be a really collaborative endeavor with me…” Here, Gracie is contrasting how the communication style developed in the PBL setting closes the authority gap between the teacher and students, and so PBL students have come to expect that their teacher operates within this relatively flattened hierarchical arrangement. Similarly, April was directly comparing her PBL and non-PBL classes when she mentioned that “they [non-PBL students] believe that the thinking begins and ends with the teacher, whereas PBL students don’t get so exhausted with having to figure things out…they [PBL students] understand that they have permission to think

and to consider options, and I think that comes from the changes I have made in how I communicate with them [PBL students].” This explanation articulates how the communication approach in her PBL classes encourages students to become problem solvers, to seek their own answers, and to weigh potentialities; all in contrast to her non-PBL students who view the teacher as a vessel that holds the answers. April went on to further compare the two groups, “In PBL we have developed them to accept some discomfort with not getting things right the first time, they expect iteration, they expect they will do something again. They’re used to the idea of prototyping, so they know that nothing is final, and certainly not after the first time…whereas in my traditional classes I feel like I almost have to kind of go soft on them….” This comment indicates how her students are showing growth in their ability to navigate ambiguity, and an overall comfort with learning in a cyclical iteration environment quite different from a traditional setting where assignments are handed in once for a teacher assigned grade. She then explained how her PBL students have developed this skill, “We communicate to them repeatedly on the process, process, process, and how their grade is attached to their ability to engage in the process more than the specific output. It’s about changing the communication about what matters at school.” The shift in student expectations and ability is directly contributed by the teachers to their focused communication on the importance of the design process in the classroom, and how that takes greater emphasis over getting the right answer in a more traditional learning environment. By placing process over product as the focus for learning, she is helping transform her own students into designers.

Anne discussed ways that her team uses deliberate communication to gain a holistic understanding of the student’s needs, and how they use this process to craft a specific culture in their PBL groups. She emphasized the importance of empathizing with her students, not only

around academics but also with regard to their overall experience in the classroom and seeing projects through to completion. “In PBL we do pre, mid and end-of project check-ins where we ask them things like ‘how are you doing?’, ‘how is everything?’, ‘how is your group going?’. We want to know how our students are doing in their project teams, if their groups are cohesive, and we want to have a finger on the pulse of the social/emotional stuff. If there are issues, let’s sit down and talk about it, let’s blow up and mix around the groups if we need to, or even let some students complete a project on their own. It’s all about the collaboration piece, it shouldn’t be teacher-driven. It should be student-driven and collaborative through and throughout the whole process.” Here she is emphasizing the ongoing importance of empathy work as a communication strategy to continually assess where students are, not only academically, but also holistically. This knowledge is derived through the process of deliberate communication she engages in with her students as a result of applying a design-oriented lens to her classroom. The participants’ ruminations about their deliberate forms of communication indicate that a shift toward a culture of design has occurred as a biproduct of their adjusted communication styles.

Move Between the Abstract and Concrete

This design ability is all about being able to think through high order conceptual ideas and concepts, but then applying those ideas in the real world (Kelly, 2017). This design ability is a safeguard from two extremes, one being the tendency for knowledge workers to become lost in abstraction, to be intellectually confined to the ivory tower, and the other tendency for practitioners to only be concerned with the here-and-now, and that which is manifestly practical (d.School, 2019). In this case, the ability to navigate between the abstract and concrete was observed in (a) activities that actualize conceptual understandings, (b) a relationship between curriculum and instruction, and (c) participants’ theoretical views on the topic itself.

Activities to Actualize Concepts

During the observed 11th Grade Charette Protocol the discussion had moved to the new topic of better developing and refining systems of assessment for the presented project. The discussion focused in on the need for students to become more effective at the process of peer critique. The need was summarized by one participant conceptually, “they [students] need to understand the cyclical nature of the create-critique-revise process, but they are still just too used to waiting for us [teachers] to tell them what to do.” He was articulating the need to shift the students further toward becoming designers themselves, and to reduce the role of the teacher as the locus of control. This conceptual understanding of the design process, and what it looks like when students are doing it properly was then followed by some brainstorming for methods and ways that students could begin to practice this high-level skill. The team ultimately formed and refined an idea where prior to an official peer critique session, students would partner. One student would have to present to the other what their favorite color was, and why that was their favorite color. The other student would then critique the students color choice and reasons. The idea behind this activity was to engage students in a low-stakes iteration of the critique process where there is no “right” answer. This solution was an attempt to bring a concrete method for students to understand an abstract conceptual model.

Two other similar instances occurred. The first example was for a project where the conceptual idea was around the role of effective local governments, and how those government’s long-term decision-making impacts the quality of life of the students who live in those municipalities; namely, school boards. During a Charette Protocol for that project, the team decided to have students go on a field trip visiting high schools in urban, suburban and rural settings to see firsthand how local municipal leadership impacts the school environments in

different areas (11th Grade Charette, Observation). This example showed how the design process, by way of a protocol, helped the team take a high level and abstract concept and bring it down to a relatable experience students could have that would give them a real-world experience that would enable them to engage in a meaningful conceptual discussion. The second example was when administrators were grappling with the abstract need to have a new hire possess an amorphous set of leadership skills, but no clear method to get at those skills through interviewing. During brainstorming, the idea of having participants complete a personality survey on their own, and to come to the interview prepared to discuss how their personality type is leveraged as a leader was suggested as a method to glean a deeper understanding of the candidates' leadership qualities (Hiring Procedure, Observation). By bringing the team's intellectual idea down to the level of action on the part of the candidate provided an opportunity to allow the team to peer under the proverbial hood and learn more about the candidate's deeper leadership motivations, strategies and tactics. These three examples represent activities designed by the participants to get at conceptual models of thinking and behavior through concrete actions.

Theoretical Meditations

The participants offered insights into their thoughts on balancing the needs of abstract conceptual thinking with practical, actionable and concrete behaviors. One participant focused on the role of deeper level considerations about best instructional practices, and how those lofty goals need to be grounded in the fundamental knowledge and skills students are traditionally expected to learn:

> I have had this kind of radical pendulum shift to the other end of the spectrum [away from traditional education] where it's all about concepts, and it's all about designing

> experiences and project based learning and that sort of thing. And you know, more recently I have really come to understand that you have to include both right? Because, you can't design an experience and get to conceptual understanding without a basis of knowledge. You've got to have that… you've got to have that fact and skill foundation in order for the higher-level stuff to happen. And finding a way to marry the two ideas…that has been kind of my more recent goal, like, what's the right balance? And what's the right sequence? And what's the right mix of different things? I want to get it right, because I don't want to go back [to traditional education]. (Dutch, Interview)

He is articulating the interaction between the high-level theoretical goals and approaches to 21st Century learning paradigms, but he recognizes the need to not lose sight of the grounded needs of a standards aligned traditional education. His bouncing between pushing the theoretical barriers, and maintaining expected content knowledge and skills is an expression of an artful dance between the abstract and concrete needs of his students.

One administrator in a curriculum development role was thinking about the challenges of his position, and specifically about how difficult it can be to have a high-level conceptual goal for student learning and outcomes that has to be interpreted into a system of units and lessons that are easily implemented with minimal theoretical understanding on the part of the teacher, but that nonetheless achieves the intended lofty goals of its original design:

> When I think about curriculum, I think it is the biggest disconnect from our office [curriculum] to the classroom… they [teachers] often attach themselves to a program and associate that as curriculum. But when we [curriculum developers] talk about curriculum, we are talking about a deeper level of student learning and experiences than just lessons and units. We [curriculum developers] are thinking

> about all the other components [of curriculum]; What large transfer goals do we have for our students? What lifelong knowledge and skills do they [students] need to have? What methods of assessment are we going to use? How does our selection and creation of assessments alter the way instruction occurs in the classroom? Are those assessments aligned to our goals for the student at graduation?...Programs without real curriculum do not answer these questions, but programs are what most teachers actually implement. So as curriculum designers we have to build curriculum that gets at these big goals, but does it in a way that is implementable in a day-to-day kind of way. We have to bring the ambiguous and abstract down to the minute-by-minute activities and instruction students receive. The more we can build the abstract into the curriculum, the more concrete we can make it there, or at least minimize the amount of abstraction at the point of instruction the more actual implementation there will be in reality. Basically, the abstract goals we have for students has to be baked into the curriculum in such a way that is it simply a matter of implementing on the part of the teacher, not interpreting our [Curriculum Developers] lofty goals and then delivering instruction. (O'Malley, Interview)

Aside from his articulation of the challenges of moving between the abstract and the concrete with regard to curriculum development, the administrator makes clear the method for making this happen. He focuses on the end user of the curriculum, the teacher, and seeks to design something for that specific audience that will produce the outcome he is hoping for. In this sense, it is his user centric focus that is enabling the balancing act between the abstract and concrete to occur. These philosophical ruminations point to the participants' clear understanding that there

exists high level discursive theory, but that it is only as good as their ability to use design thinking to bring the lofty down to the point of practicable, user friendly application.

Rapid Experimentation

Rapid experimentation is a foundational action for design thinkers (Kelly, 2017). It is about generating ideas quickly, and then developing those ideas just enough for them to be tested by others in order to receive feedback, thereby kickstarting further refinements in prototyping. As a design ability, it is about designers reaching out to users to beta test and provide insights on what is and is not working with the design as it is (d.School, 2019). In this case, rapid experimentation was observed through (1) focused ideation phases embedded within protocols and guided activities, and (2) evidence of a living process of iteration and prototyping.

Ideation

The Project Based Learning team developed one protocol, the 50 Projects Protocol, for the explicit purpose of formalizing an ideation process tailored to their needs. The protocol, described in detail above (Design Your Design Work), is essentially a focused brainstorming activity that helps the team of PBL teachers support one teacher seeking to explore what projects they could develop to support their students. In the protocol's directions, it introduces the purpose and function of the protocol with the following: "This is an exercise in brainstorming, and the focus is on quantity! quantity! quantity!" (50 Projects Protocol, Document). From the start, it is prompting the team to think divergently, and to generate a volume of ideas. In the directions for the brainstorming phase of the protocol, they further direct and support this idea, "This is not a time to 'think' deeply or thoughtfully…Do not evaluate your thoughts during this stage…Good ideas, bad ideas, wild ideas, impossible ideas, they all get included…As time begins to close and you think you have run out of thoughts, allow yourself to include the

impossible!" (50 Projects Protocol, Documents). The inclusion of these instructions indicates the teams desire to short circuit the mind's natural tendency to want to stick to a single idea, and talk it over or think it through, and to instead favor a process that drives rapid idea production. The directions further support this focus on ideation when outright declaring that as a participant, they will likely begin to run out of ideas, at which time they should become more unhindered by practical considerations and suggest more divergent or vanguard ideas.

A similar set of directions and instructions were provided to the team observed during the Design for an Extreme User meeting. The team was asked to conduct rapid ideation around potential methods that could be used to support their "extreme user" identified student who needed support to better connect with the PBL learning environment. Teams generated their ideas on sticky notes and placed them on a large sheet of butcher paper. It was noteworthy that the facilitator circled between the different teams during this time and was encouraging and reminding teams to keep moving to new ideas. When the facilitator heard teams naturally slide into conversations about one presented idea, he would interrupt and nudge the team to continue generating new ideas. The end result was that the four teams all produced well over a dozen potential ideas to consider in just over 10 minutes (Design for an Extreme User, Observation). It was the facilitator's constant needling of the participants to stay locked into the idea generation modality of thinking that enabled this experience to have produce results.

Iteration and Prototyping

The data management system developed for principals went through a process of prototyping and revision. Following the team's initial improvement plan document, it was shared with two identified principals who were viewed as having the highest data usage proficiency (Data Management, Observation). Their feedback produced a revised version which was then

reshared with them the following day, revised again, and shared with the remaining district principals who provided further feedback. It was then revised a final time and shared with all principals. A few additional recommendations were included in the final version that was then formally adopted by the district (Data Management, Document). This was a clear expression of designers making concerted efforts to involve their end users in the process of creation and revision, as the commitment to repeated prototypes made apparent.

One teacher who created an independent STEM experience for all students in his elementary school was discussing his use of design thinking as a procedure for innovating this new program. He commented on the specific role of constantly revising his ideas, "by using the rapid iteration cycle of revision I get a much better product in the end. So I had a teacher this year who observed a [STEM] lesson that was delivered to her class last year, and then she came back recently [12 months later] and she observed the same lesson again, but it had been through something like 6 or 7 iterations, and by that time it was a completely different lesson than she saw the first time, and [it] was so much better because it was more coherent and better aligned to what students at that age can do." His specific identification of using rapid iteration as a method for gradual improvement is a sign that he is not simply tinkering, or generally engaging in continuous improvement, but rather leveraging the design process specifically. The improvements made were not just from his perception, but corroborated by the teacher who witnessed the first and last prototypes.

An administrator who supports teachers in the Project Based Learning program was sharing how the district's purchase of 3D printers, and their use as an instructional tool by PBL teachers was a successful way of allowing for rapid iteration and prototyping to occur:

> One of the things we do here now is 3D printing to help students quickly prototype their ideas…they have a design, maybe they have drawn in out in 2 dimensions, or as a 3-dimensional CAD file…and instead of waiting, or spending hours and hours trying to build their idea full scale we can rapidly prototype, we can spit out a design knowing that it's going to fail…we can throw something together as quickly as possible just to test it out…Test the theory, knowing that it will fail in some way. At first this can seem like a waste of time, but it's actually a time saver because you find out what works and doesn't work much faster. The whole idea that your first design is not going to be perfect is the reason why we protype in the first place. Find out where it is perfect, and keep that, and where it is not perfect, and change that part. You will actually get to a better final product faster using that method. (O'Malley, Interview)

This focus on producing that which you know will fail, is a perfect expression of having a designer's mindset around rough prototyping, and having a design thinking mentality with regard to iterative cycles of improvement leading to a superior refined outcome. In this example, building that mentality into the student experience directly to inculcate their comfort with the idea of continuous improvement through iteration.

Lastly, it is worth revisiting the Project Based Learning team's development of the three protocols as a methodology by which the projects they develop are run through a process of at least three cycles of iteration prior to launching the project with students. The 50 Projects Protocol being the first layer of idea development and ending with a direction for the team to develop this idea into a coherent project, followed by the Charette Protocol where that coherent project is presented to a design team and specific

areas of underdevelopment are targeted for design support in order to refine the project, and ending with the presentation of a nearly complete project that is then run through a Tuning Protocol to further provide feedback and recommendations prior to students being exposed to the idea (50 Projects Protocol, Document; Charette Protocol, Document; Tuning Protocol, Document). The total process can then be reformulated as:

(1) Collaborative design team works to identify a potential project through the 50 Project Protocol.
(2) PBL grade team works independently to build and develop a working prototype of a potential project.
(3) Prototype is presented to the collaborative design team, and specific areas in need of improvement are identified and discussed during the Charette Protocol. (Students are often included at this stage.)
(4) PBL grade team works independently to further refine and develop the project toward a more finalized version.
(5) Refined prototype is presented to the collaborative design team who then critique the totality of the project to offer areas for improvement and revision.
(6) PBL grade team works independently to further hone the details of their project.
(7) Project is launched to students.

When viewed as a total system, there are seven distinct steps of development that occur from start to project launch. The process moves back and forth from work conducted by the broader collaborative design team, and the narrower grade specific PBL team who develops the specifics of the project in relative isolation before reemerging to the larger

team to present and receive feedback. It is also noteworthy that the protocols at each phase are oriented to the needs of the typical “stuckness” of the design process at that phase. What binds this to Rapid Prototyping as a design ability is that the participants designed this process themselves by selecting and modifying protocols they found from outside sources and building this system as described above. Overall, individual teachers, administrators, and larger teams were all observed and discussed their use of systems of iteration and prototyping.

Conclusion

This case study explored the findings from six interviews and six field observations of design thinking-centered team meetings, as well as a review of five design thinking team crafted documents. The findings were initially organized and analyzed through the lens of the Eight Design Abilities of Creative Problem Solvers, namel:y (1) Navigate Ambiguity, (2) Design Your Design Work, (3) Learn from Others, (4) Build and Craft Intentionally, (5) Synthesize Information, (6) Communicate Deliberately, (7) Move Between the Abstract and Concrete, and (8) Rapid Experimentation. As the data was further analyzed within these groupings, they were further subdivided into empirically derived categories that erose naturally through the two-cycle coding process.

Chapter 5: Findings

This study is part of a larger body of research seeking to identify methodologies and practices that enable innovation to thrive withing the K-12 public education system. For this research, design thinking (DT) was identified as the specific methodology for deeper study given its ability to: (a) make people and teams more innovative (Brown, 2019), (b) change institutional cultures to be more creative and solution oriented (Seitz, 2019), and (c) create conditions necessary for innovation to thrive within established organizational structures (Ney & Meinel, 2020).

Although these DT-fostered abilities are established in the business sector, this study sought to reflect on the experience of bringing this methodology into the domain of K-12 public education. As such, this intrinsic case study explored the experiences of a group of educators using design thinking to innovate solutions to the intractable problems they faced. The participants were teachers and administrators previously trained in the use of design thinking, and in roles where DT is used as part of their professional practice. The study was guided by two research questions:

> (1) Experientially, what is it like to implement design thinking as a problem-solving tool in a traditional K-12 public school system?
>
> (2) How does the use of DT manifest as competency in the Eight Design Abilities of Creative Problem Solvers?

In order to answer these questions, this intrinsic qualitative case study collected field observations, interviews, and documents to frame the research. Specifically, field observations gave witness to DT in action, interviews centered on discussions of the Eight Design Abilities of Creative Problem Solvers, and document reviews examined what the observed DT work

produced. The data was reviewed using two cycle coding where (1) the first round used *a priori* codes derived from the Eight Design Abilities of Creative Problem Solvers, and (2) a second round of *in vivo* coding allowing natural themes to emerge within the *a priori* codes.

This case study's results indicated that the use of design thinking as a methodology for producing innovation within a K-12 public educational setting enabled educators to (1) express their experience of and (2) develop their skills associated with the Eight Design Abilities of Creative Problem Solvers. The theoretical ruminations of participants on their use of DT came through the interviews, while their observed behaviors and the documents produced by the various practitioners provided a lens into the ways that the design abilities manifested in this particular case study setting.

Application of the Theoretical Framework

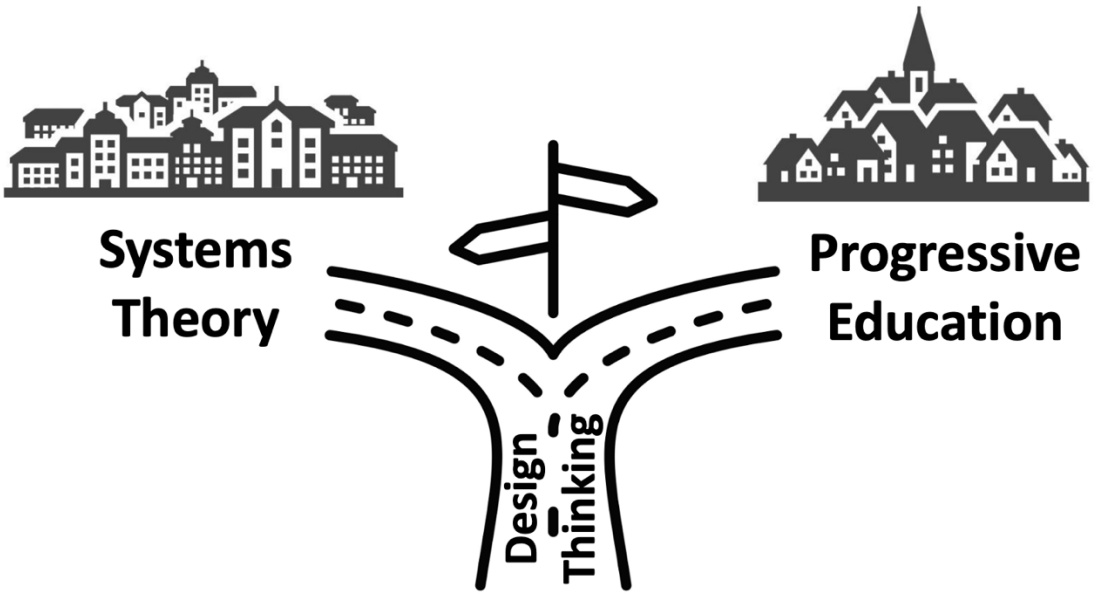
This research study originally employed a theoretical model of three concepts nested within one another: (a) Progressive Education as an inspiration for the loftiest goals an educational institution can aspire to, (b) Systems Theory as a conceptual model to better understand the seemingly chaotic and complex workings of a large organization, and (c) design thinking as a specific methodology to inculcate a set of behaviors to bring about a progressive educational system and to actively work against the forces of entropy.

Originally, the researcher viewed these three concepts as working in a nested relationship, and was represented as a set of Russian nesting dolls (see figure 8). This hierarchical relationship between the three framework lenses was informed by the researcher's role as a central office administrator, and represents an applied practitioner's viewpoint. However, when evaluating the results, what emerged suggested a different relational organization if looking directly at the data collected. Rather than the ideas resting hierarchically

within one another, design thinking emerged as the pathway, or road, that paved the way for both progressive education, and systems thinking to manifest themselves within the research. As such, a new relationship has appeared and is represented in Figure 10 below. This shift from Figure 8 to Figure 10 is a matter of viewing the data through an administrator (Figure 8) or researcher (Figure 10) positionality.

Figure 10

Design Thinking as a Pathway



Note: DT acts as a way to foster (1) systems theory and (2) progressive education

Design thinking acts as a procedural methodology for teams of people to engage in innovation to derive unique solutions to highly complex challenges (Brown, 2012), is incrementalist (Halpern & Mason, 2015) and operates through iterative adjustments (Micheli et al., 2018). DT supports Progressive Education in that it is aligned to experiential learning, is student-centered, and prepares students to be community members and citizens, and as such can help bring about the Progressive Educational ideal into the 21st Century. This innovative approach stands as a potential methodology to support Systems Theory, as it: (a) engages with

our schools holistically, (b) incorporates feedback loops into its solution making, and (c) acts as a methodological and cultural antidote to entropy. Throughout the study, DT was witnessed to manifest itself in action through the Eight Design Abilities of Creative Problem Solvers.

Overall, DT introduces a procedural method to inculcate innovation as the *de facto modus operandi* of our K-12 public education system to simultaneously: (a) reform our education system to better match the needs of our current time by offering our institutions a method to behave differently, (b) nsert Progressive Education as a procedure, and (c) stave off the effects of institutional entropy.

Design Thinking Enables Progressive Education

Progressive Education was established to inculcate in students the paired democratic societal behaviors of (a) pro-social participation in representative government and (b) effective collective problem solving (Dewey, 1916). Specifically, Progressive Education leverages three means to achieve this end; (a) experiential learning, (b) a child-centered focus, and (c) the skills required for successful community living (Dewey, 1899, Dewey 1910, & Dewey 1939). As such, Progressive Education became an alternative to Traditional Education, as the conventional approach focused on student mastery of content and skills derived through repetition, memorization, and rote learning.

This study showcased a particular way of bringing progressive approaches to curriculum design and lesson planning into classrooms. The Project Based Learning team's use of design thinking protocols had a range of progressive alignments. The focus of PBL on actualizing student learning and doing so through experiences rather than content and skills is a direct link between these two approaches. The participants' repeated inclusion of students into the design process for projects is a clear indication that teachers using DT center their "users" (i.e.,

students) and embed them in the decision-making process about their own instruction. Lastly, the open borders between administrators, teachers and students throughout the project development process is an expression of a community approach to curriculum development that makes the abstract ideas of progressive "community" become a set of concrete actionable items.

Design Thinking as a Method of Applied Systems Theory

Systems Theory is a way of conceptualizing and understanding highly-complex human organizations through three primary lenses (Katz & Kahn, 1968). The first lens is to view the organization as a holistically operating entity, and not as a collection of departments or independent functions, by observing how the pieces are interdependent and provide feedback to one another. Ultimately, the aim is to map the interconnected systems to gain a broad view of the organization as a living social system (Beckt, 1974). The second lens is to see the organization as a network of positive and negative feedback loops, and how those feedbacks influence the processes of the organization over time (Almaney, 1974). The third lens is to presume the presence of entropy within the organization, and thus to assume that its functions are slowing down, deteriorating, disorganizing, and becoming corrupt (Bailey, 2006). When applied to the K-12 public educational sector, Systems Theory is a way to better understand how our system operates, and to help craft effective changes that will positively impact students.

The interviews, observations, and documents reviewed from administrators reveals a particular view of DT as a way to better operate the problem-solving machinery of school systems. The approach to reforming the way the school district of this case study approached the use of data management was an expression of DT operationalizing methods to gain a holistic understanding of how the institution works across schools, departments and individual roles. Similarly, the administrator's use of empathy during the reinvention of their hiring procedure

showed how DT derived insights from both interviewers and interviewees about their motives and experience of various feedback loops. While these may appear as singular anecdotes, they speak to the nature of DT to encourage its practitioners to (a) establish a broad understanding of all the systems and individuals that make up a problem and (b) derive insights into the experience of users to derive a human understanding of the reward and punishment systems that produce the current set of problems, and as a way to potentially see a path for innovation and solutions. Lastly, throughout the study, DT was observed and discussed as inculcating both creative confidence and the power to navigate ambiguity. The combination of creative confidence and successful ambiguity navigation suggest that DT works against entropy.

Discussion of Results

This case study examined the experience of participants utilizing design thinking as a modality for solving the challenging problems they faced. Following analysis of the data, three core themes emerged that bind all of the coding structures and other observances together: (1) The participants embodied a kaleidoscope of mindsets that indicated an evolution from mere teacher or administrator into that of *designer*, (2) the developed skillset of utilizing design based activities and procedures produced the necessary creative confidence to feel empowered when navigating through ambiguity resulting in the development of potential solutions to their problem, and (3) collaboration was observed as a universal ethic, action and behavior.

The Participants Became Designers

Typically, DT is described as a process, with nearly all DT training modules introducing the topic as a series of phases, and the intellectual conceptualization of DT is almost always framed as a working through of the process from beginning to end, albeit in a non-linear fashion.

The participants in this study were trained in their use of DT in this way, following Stanford d.School's five stage process.

This study indicated that within this K-12 public educational paradigm, DT did not manifest itself as repeated use of DT as it was taught, instead, DT became incorporated as a set of abilities employed by the practitioners in a more *ad hoc* way. The training and use of design thinking appear to inculcate in the participants a set of mindsets and skills aligned to the discipline of design, rather than as a devotional reliance on the DT process. Specifically, the abilities observed fit nicely into the conceptual model of the Eight Design Abilities of Creative Problem Solvers. This alignment was on open display throughout the data collection and coding phases of this research, and suggests that more attention be paid to supporting and fostering these abilities directly.

For example, the DT phase Empathy manifested as the participants' design ability to "Learn from Others", as evidenced by their own statements and the Empathy activities built into their protocols. The define stage appeared through beliefs and observed methods that align to the ability to "Synthesize Information", particularly when summarizing findings from the Empathy phase. The Ideation phase of DT appeared as a set of skills and practices around "experiment rapidly" and "learn from others", like when protocols were designed to push collaborative teams to produce large volumes of potential solutions. The Prototyping and Testing phases were observed as a set of beliefs and actions around both "experiment rapidly" and "build and craft intentionally", as seen in the inclusion of end users in the design process itself, putting iterative prototypes in front of users, and soliciting feedback throughout the design cycle. The expressed philosophical ideas, and observed skills and behaviors witnessed throughout the study were

direct articulations of these abilities, from which the DT process could be seen to be operating as a kind of background intellectual software.

Overall, what was observed could be described as a demonstration of a wide range of "designerly ways of knowing" (Cross, 2001). In other words, the participants appeared to have gone through an intellectual metamorphosis whereby they became *designers*. They tackled *wicked problems* by applying a design lens to their thinking and actions; thereby approaching their problems as mere design projects, and reaching into their design toolbox for actions to move closer to a viable solution.

Creative Confidence was Experienced Through Proper Design Activity Selection

Protocols, procedures, guided discussions, and a wide variety of other design activities operationalized design thinking throughout this case study. Although the DT process can certainly be teased out of the data, it was primarily the use of guided methodologies that paved the way for the design process to functionally operationalize; to put it in the terms of the Eight Design Abilities of Creative Problem Solvers, participants "designed their design work". Doing so produced an experiential confidence in their ability to be creative, and it was this creative confidence that empowered them to navigate through the ambiguity of not knowing how they would solve their respective problems. As such, each individual's and team's ability to chart a course through a set of design activities determined the extent of their prowess as designers.

"Designing the design work" was on particular display in the way that the Project Based Learning team built their system of protocols to guide the development of their projects to completion. Their custom development of three phases of protocols to move the design process forward was a successful example of using design activities to make their way through the process in a user-friendly manner. As such, the PBL protocols allowed for the sometimes

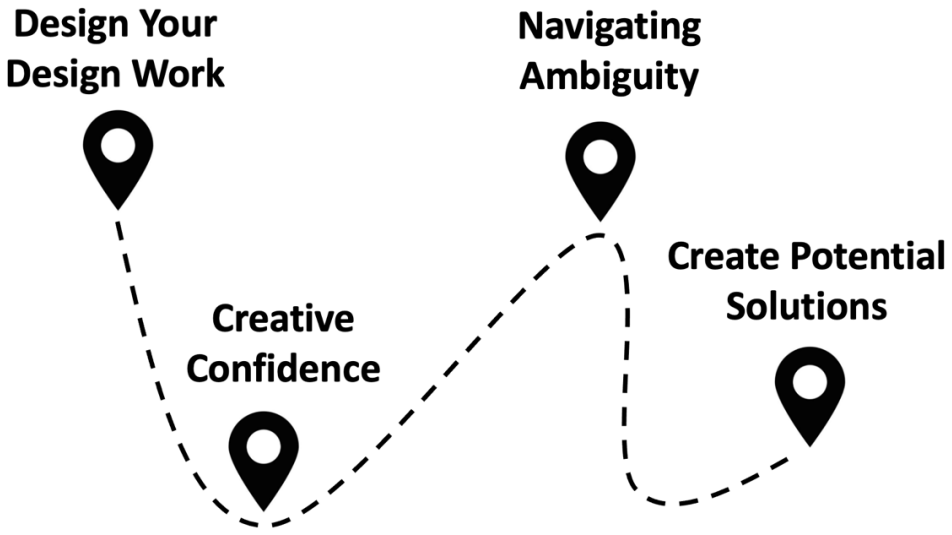
amorphous and intellectualized design thinking concept to become something concrete and useable. So, participants were enthusiastic about engaging in the protocols, and frequently requested their colleagues convene to put them into practice.

The administrators' use of carefully-selected activities to drive a design experience forward operated similarly to the teachers' use of protocols, but the administrators demonstrated a greater ability to mix and match activities as needed. In this study, administrators would even reference Design thinking textbooks mid-design to select the next appropriate step for the team. It was also the administrators who described that problems are just design projects waiting for a solution. This heightened confidence in design thinking suggests that the depth of the designer's design activity toolbox is linked to their sense that they have the ability to solve problems.

Overall, a process was observed whereby (1) the act of carefully designing the design work (2) produced creative confidence that (3) empowered participants to navigate through the ambiguity of not-knowing (4) thereby creating the conditions for a potential solution (Figure 11).

Figure 11

The Path to Solutions

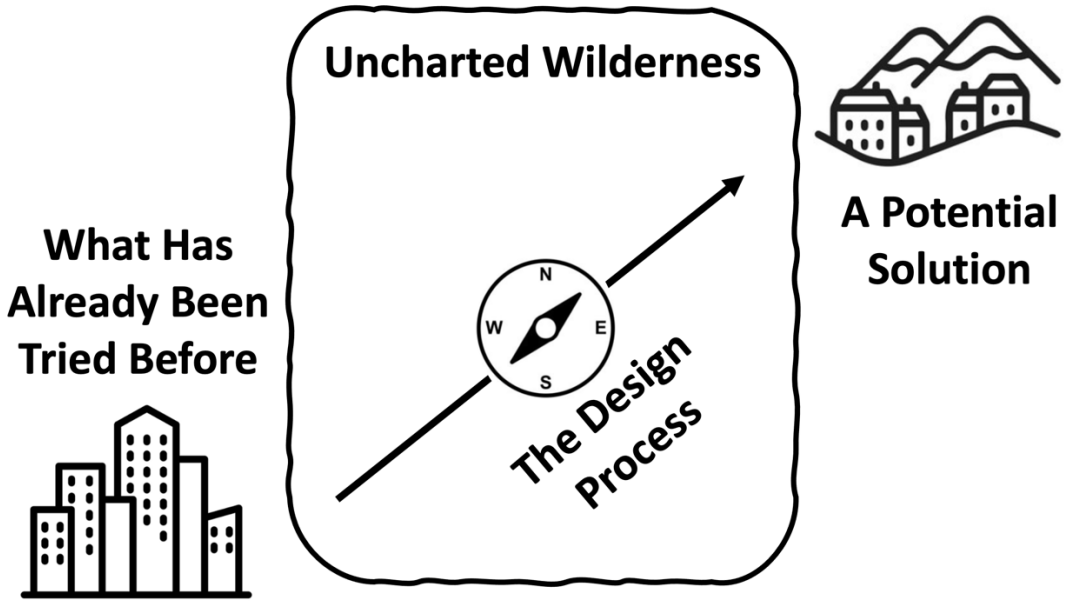


Note: The linear and directional relationship between the first three abilities leads to solutions.

This case suggested that design thinking offered the participants a modality of strategies and actionable items, perhaps best thought of as “tools”, that encouraged them to operate in the often avoided psychological state of uncertaintly, which is the place where solutions are found. Another way to conceptualize this process is that design thinking acted as a compass, allowing the participants to traverse through an unknown wilderness, unaware of the location of rivers, gorges and cliffs, but to nonetheless confidently plot a path to a desired location (see Figure 4).

Figure 12

DT as a Compass



Note: DT can act as an intellectual compass to navigate amiguity to reach a solution.

Overall, the combination of Participants’ views of themselves as designers and their aptitude at leveraging the design process produced a common experience of confidence in their ability to solve *wicked problems*.

Collaboration as a Keystone for Success

Although all of the Eight Design Abilities of Creative Problem Solvers have overlap and are interdependent, the one common experienced across all the abilities was “Learn from

Others". While in some industry sectors this may not be of particular note, the teaching profession is isolating, siloed, and many attempts at inculcating collaboration have been unsuccessful (Hargreaves, 2021; Schlichte et. al., 2005). As such, the common occurrence of teamwork observed throughout this case is of particular interest. The common experiences of collaboration were most noteworthy in that it was (a) pervasive throughout all design work, (b) referenced and called for as a key ingredient in the making of successful products, projects and solutions, and (3) occurring organically.

There was no observed design work that occurred as an individual endeavor. Likewise, no interviews stated or implied that Participants conducted significant work in isolation. The observations all showcased collaboratively created designs, and teamwork as part of the design process. Even in the PBL teams who presented projects that had been partially designed prior to being critiqued, the grade teams delivering the associated instruction developed those projects. The analyzed documents collected during this study all showcased team derived products. Simply put, the use of design thinking within this case was universally collaborative.

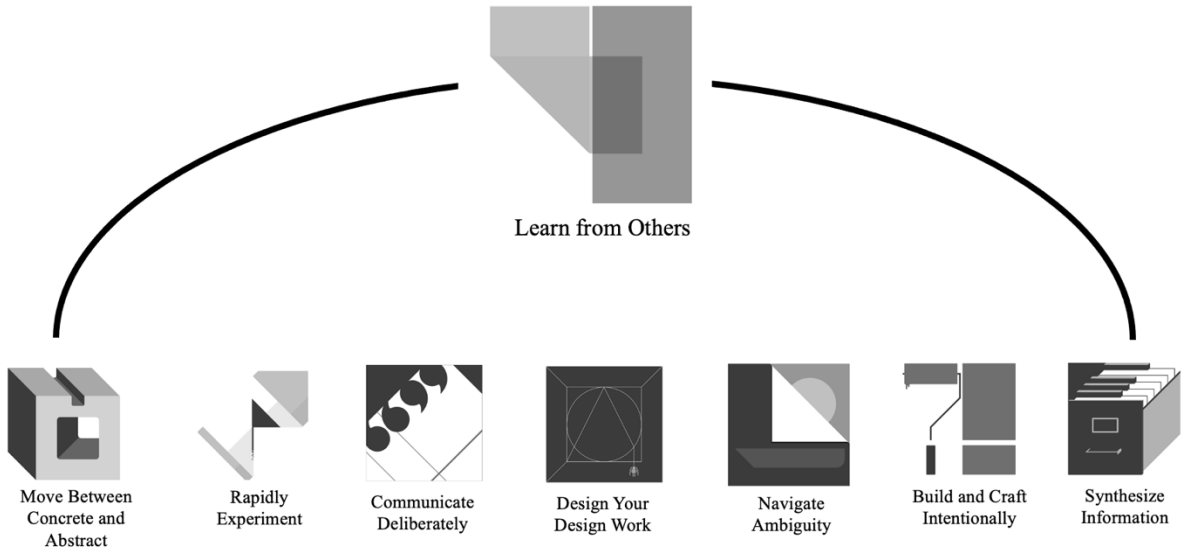
Throughout the interviews the reliance on collaboration was often directly stated and frequently implied. When administrators developed the new data management system, they were obsessively seeking outside voices and collaboration throughout the process. When PBL teachers discussed being stuck in their project creation progress, they referenced the need to bring in their colleagues. When an innovative teacher working in relative isolation wanted to create a new student experience, he went right to his regular education teachers for their insights, critiques and blessings.

The benefits of collaboration and the desire to engage in group thinking was a requirement for all of the observed design abilities to be experienced. In this sense, collaboration

was the glue that bonded the abilities together, and acted as the keystone or common denominator ability. See Figure 5 for a representation of the Eight Design Abilities of Creative Problem Solvers with “Learn from Others” as the common experience found throughout:

Figure 13

Learn from Others: The Glue that Binds



Note: “Learn from Others” was observed to be a prerequisite for all of the other abilities Adapted from “Eight Design Abilities of Creative Problem Solvers” By Stanford University d.School. Creative Commons.

As such, “Learn from Others” in this overarching role points to a significant shift in the way the participants of this study operate in comparison to more traditional teaching and administrative settings. Perhaps the most noteworthy finding was that this shift to a more collaborative work modality occurred naturally as a biproduct of using design thinking. The teachers and administrators in this setting had typical schedules and constraints as may be

experienced by others not utilizing DT, but the drive to collaborate produced this naturally occurring prioritization of collaboration to occur.

Limitations

As with all research studies, this study contained several limitations. Those limitations included common issues found throughout all intrinsic qualitative case study models based on the Stake method (Stake, 1995). These include the employing of first cycle *a priori* coding, the unexpected inclusion of students producing the cancellation of some field observations, and limitations of generalizability associated with case studies and this particular research setting.

Methodology

This study was limited by the structures aligned to case study research guided by the work of Robert E. Stake (1995). The use of interviews, observations, and document reviews may have produced misleading data as participants might have adjusted their responses during interviews and behavior during observations in order to provide what participants perceived the researcher wanted to see and hear. This is a reasonable concern, as the researcher was in a position of leadership within the school district of this study, and the power dynamics of that relationship may have influenced the responses, behavior, and products observed throughout. To counteract this concern, no participants were included who are formally observed or evaluated by the researcher. Similarly, the researcher's previous commitments to the application of design may have impacted their ability to accurately see evidence and data. To overcome this limitation, the researcher incorporated notation and memo cross-referencing, and participant approval of analysis and results.

Like many case studies, this study would be difficult to replicate, particularly as a result of the previous investments into design thinking prior to the study the participants received, and

the particularities of the Project Based Learning team being researched. To conduct similar case studies in other places would be time consuming and cost prohibitive, particularly regarding the need to provide in-depth design thinking training prior to research. Lastly, the subjectivity of case study research provides general limitations to applicability beyond the specific case studied in this research.

A Priori Coding

A priori first cycle coding was utilized when analyzing the data collected during this study. This method limits the initial set of potential emergent themes, as the researcher has arrived to the analysis process with a coding structure already established, in this case based on the 8 Abilities of Creative Problem Solvers. To mitigate against this limitation the second cycle of codes were developed empirically in order to enable themes and connections to surface without boundaries. This approach produced 8 first cycle codes, and 25 second cycle codes to emerge by the conclusion of the data analysis process.

The Unexpected

The Project Based Learning team made liberal use of students as part of their design teams when running protocols to develop projects, as referenced to through interviews shared in the data results section of this research. While this is certainly a user-centric design thinking best practice, the scope of this study did not include student participants. As such, those protocols that included students were not observed as part of the field observations. Had students not been invited as participants to those protocols, several more field observations would have been included in this study.

Generalizability

This study was limited to one school district setting, and thus not generalizable beyond the studied participants. Additionally, the small sample size of participants limited the degree to which the findings are generalizable to those engaged in design thinking work within the K-12 public education system. The modality of data collection was limited to a qualitative intrinsic case study design, thus lacking positivist and quantitative measures, thereby reducing the findings' generalizability beyond the borders of this case. Lastly, the purposeful selection of participants with previous design thinking training and current usage results in data that are not generalizable to those seeking to establish design thinking as a new method for problem solving.

What the Future May Hold

This research study suggests the need for further research in the areas of (1) design thinking activity selection and use, and (2) the intersection of design thinking and collaboration within the confines of K-12 Public Education. Similarly, this study recommends future practices shift toward (1) an abilities-centered professional development focus, and (2) methods for being flexible users of design thinking activities to navigate the particular ambiguities of each design problem.

Recommendations for Future Studies

This study indicated that the participants' use of design activities was an essential first step in order to successfully steer a design experience to a satisfactory conclusion. More research is needed around the topic of design activity selection within a K-12 public educational setting. Although there are hundreds, perhaps thousands, of previously developed design activities from a wide range of sources, many of them are tailored toward more traditional design fields such as architecture, computer science, product development, and customer experiences. A study is

needed to explore those activities design thinkers commonly use within the field of education, and to explore those activities not as commonly used that may benefit this sector of DT practitioners.

There already exists a deep well of research on the topic of teacher collaboration, with a particular focus on the use of Professional Learning Communities as a method to inculcate collaboration. Even when utilizing best practices, A common finding in this research is the difficulty of both establishing and maintaining collaboration (Hargreaves, 2021; Schlichte et. al., 2005). This case study suggests that more research is needed on the use of DT as a new methodology that may organically foster collaboration outside of more traditional approaches, such as PLCs.

Recommendations for Future Practice

This case study showcases the importance of the Eight Design Abilities of Creative Problem Solvers as a set of modalities whereby design thinking manifests through the actions and behaviors of those leveraging this problem-solving approach. The training the participants received prior to this study in design thinking was entirely centered on the process of design thinking itself, with no mention of design abilities – and yet, it was the design abilities that primarily emerged at the experiential level. This finding suggests that future training should include a direct focus on the development of the Eight Design Abilities of Creative Problem Solvers in tandem with a philosophical understanding of the design thinking process.

David Kelley's identification of the existence of the Eight Design Abilities of Creative Problem Solvers only recently occurred in 2017 (IDEO U, 2017). Since then, a slow shift can be observed to provide more resources for those seeking to foster these abilities. So far, Stanford's d.School has developed the most robust set of training materials; however, they have not yet

created modules for all eight of the design abilities (d.School, 2019). So, as it stands at the time of writing this document, there is currently no complete training system to support all of the Eight Design Abilities of Creative Problem Solvers.

There is still room for practitioners to become familiar with the abilities and what they seek to identify in highly-functional, practicing designers. When leading teams who are using design thinking, this adjusted focus can allow leaders to hone in on the mentalities and skill sets of their design teams working within a DT framework, as opposed to being singularly focused on the process alone. This re-shifting of focus would be a more individualized and humanized approach and may get traction with educators who may lean into this approach more than the typically technical DT trainings.

Another area for future practice is in the direct training on the use of self-selected design activities to navigate through each design problem encountered by design thinking practitioners. One moment observed in this case study was when the administrative team that was developing a new hiring procedure. Throughout the procedure, the team would pause the design process in order to reference Robert Curedale's *Design Thinking: Process and Methods*; a 700-page tome containing hundreds of different design activities. Once a designer selected the proper design activity, the team would continue their design work utilizing this newly identified procedure. This particular skillset is what may very well separate beginner and intermediate designers from their more expert compatriots.

This skill of proper activity selection can be easily taught, so that designers are not confined to either a narrow set of protocols and procedures, or a feeling of being bound to the discrete phases of design thinking as it is typically taught. Instead, future practitioners should be armed early in their training with the skillset to hunt down the right experience that will help

them overcome the particular hurtle they are facing at that time in the design process. To put it in terms more closely linked to this research study, DT trainers ought to focus on inculcating practitioners' design ability to "Design your Design Work" as a discreet training objective.

Summary

This intrinsic qualitative case study conducted interviews, field observations and document reviews of educators previously trained in design thinking to witness their experience in the use of this methodology to solve the problems they faced. Throughout the study, the participants' statements, actions and products indicated their capacity to function as exemplars of the 8 Abilities of Creative Problem Solvers. The educators showed how they had become *de facto* designers, their practice indicated the centrality of design activities to foster confidence in their ability to navigate ambiguity, and that the heart of their design work was bound by their organic and liberal use of collaboration.

Overall, the educators participating in this case study gave testament to how the constellation of abilities they developed empowered them to solve *wicked problems.* Specifically, their confidence to wade into the cool dark waters of ambiguity as the best means to find a hidden solution exemplified their becoming *design thinkers*.

> "τὰ γὰρ πράγματα οὐκ ἀλλὰ τὰ δι' αὐτῶν δόγματα δεινὰ ἐστίν. οὐ γὰρ λύειν τὰς ἐναντιότητας χρεία ἐστίν ἀλλὰ τὸ διανοεῖσθαι αὐτάς ἐπιτέμνειν. τὰ γὰρ καθήκοντα ἐκ τῶν προκειμένων ἀποτελοῦνται καὶ τὰ προκείμενα πάντα ἐφ' ἡμῖν."

***

"The mind adapts and converts to its own purposes the obstacle to our acting. The impediment to action advances action. What stands in the way becomes the way."

~Marcus Aerelius, from *Meditations* 160AD

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Appendix

Appendix A

Recruitment Email/Letter

Dear [Name]:

I am conducting a research study on the application of Design Thinking as a procedural framework in K-12 education. Due to your use of Design Thinking in your professional role, you are invited to participate in this research study, should you so choose. Participation will take 120 minutes, split between two interviews, two observations and a review of team created documents. If you are interested, please respond to this email in the affirmative.

Statement on compensation and risks: There is no compensation for participating in this study. It is possible that participant confidentiality could be lost, there could be a loss of privacy, some individuals may experience a loss of free time during work hours or a loss of free time outside working hours. Some may experience some discomfort with the content of interview questions, or experience mild anxiety when answering questions related to their professional experience.

If you have any questions, please let me know.

Matthew Pimental
[redacted]

Appendix B

Project Title: Design Thinking in K-12 Public Education Case Study

Investigator(s): Matthew Pimental; Heather Schugar

Project Overview:

Participation in this research project is voluntary and is being done by Matthew Pimental as part of their Doctoral Dissertation to Design Thinking (DT) is an intellectual procedural framework that helps teams produce innovative solutions to challenging, complex and nuanced problems. Design Thinking offers a compelling case for being a way to support educational institutions seeking to foster creative thinking to better solve the many challenges education is currently facing. Your participation will take about 120 minutes to Participate in two interviews, participate in two teacher team meeting observations, Review of teacher created documents. There is a minimal risk of It is possible that participant confidentiality could be lost, there could be a loss of privacy, some individuals may experience a loss of free time during work hours or a loss of free time outside working hours. Some may experience some discomfort with the content of interview questions, or experience mild anxiety when answering questions related to their professional experience. There is no direct benefit to participants for agreeing to engage in this research study to you as the participant, and this research will help A gained understanding of the particularities of implementing Design Thinking as a procedural framework in K-12 education.

The research project is being done by Matthew Pimental as part of their Doctoral Dissertation to Design Thinking (DT) is an intellectual procedural framework that helps teams produce innovative solutions to challenging, complex and nuanced problems. Design Thinking offers a compelling case for being a way to support educational institutions seeking to foster creative thinking to better solve the many challenges education is currently facing. If you would like to take part, West Chester University requires that you agree and sign this consent form.

You may ask Matthew Pimental any questions to help you understand this study. If you don't want to be a part of this study, it won't affect any services from West Chester University. If you choose to be a part of this study, you have the right to change your mind and stop being a part of the study at any time.

1. **What is the purpose of this study?**
    - Design Thinking (DT) is an intellectual procedural framework that helps teams produce innovative solutions to challenging, complex and nuanced problems. Design Thinking offers a compelling case for being a way to support educational institutions seeking to foster creative thinking to better solve the many challenges education is currently facing.
2. **If you decide to be a part of this study, you will be asked to do the following:**
    - Participate in two interviews
    - Participate in two teacher team meeting observations
    - Review of teacher created documents
    - This study will take 120 minutes of your time.

3. **Are there any experimental medical treatments?**
    - No
4. **Is there any risk to me?**
    - Possible risks or sources of discomfort include: It is possible that participant confidentiality could be lost, there could be a loss of privacy, some individuals may experience a loss of free time during work hours or a loss of free time outside working hours. Some may experience some discomfort with the content of interview questions, or experience mild anxiety when answering questions related to their professional experience.
    - If you become upset and wish to speak with someone, you may speak with Matthew Pimental
    - If you experience discomfort, you have the right to withdraw at any time.
5. **Is there any benefit to me?**
    - Benefits to you may include: There is no direct benefit to participants for agreeing to engage in this research study
    - Other benefits may include: A gained understanding of the particularities of implementing Design Thinking as a procedural framework in K-12 education.
6. **How will you protect my privacy?**
    - The session will be recorded.
    - Interviews will be recorded using Zoom
    - Your records will be private. Only Matthew Pimental, Heather Schugar, and the IRB will have access to your name and responses.
    - Your name will **not** be used in any reports.
    - Records will be stored:
        - Password Protected File/Computer
    - Interview and observation recordings and written materials, as well as documents and associated documents will be stored on a password protected external hard drive. The hard drive will be stored in the office of the researcher's home at [redacted]. The researcher and faculty sponsor will have exclusive access to the data. The data will be destroyed 3 years after the publication of the researcher's dissertation.
    - Records will be destroyed Three Years After Study Completion
7. **Do I get paid to take part in this study?**
    - No
8. **Who do I contact in case of research related injury?**
    - For any questions with this study, contact:
        - **Primary Investigator:** Matthew Pimental at [redacted] or matthew.pimental@gmail.com
        - **Faculty Sponsor:** Heather Schugar at [redacted] or hschugar@wcupa.edu
9. **What will you do with my Identifiable Information/Biospecimens?**
    - Not applicable.

For any questions about your rights in this research study, contact the ORSP at [redacted].

I, _____ (your name), have read this form and I understand the statements in this form. I know that if I am uncomfortable with this study, I can stop at any time. I know that it is not possible to know all possible risks in a study, and I think that reasonable safety measures have been taken to decrease any risk.

_____

Subject/Participant Signature Date:_____

_____

Witness Signature Date:_____

Appendix C

Applied Design Thinking Interview Questions

1. In what ways has the use of DT impacted you, or your teams, way of solving problems?
2. How has your experience as a problem solver changed?
3. How does DT impact your ability to be creative when solving problems?
4. Do you think you/your team would have developed what you have without the use of design thinking?
5. Which phase of the DT process do you find the most helpful, and why?
6. Which phase of the DT process do you struggle the most with?
7. How has the user centric approach of DT altered what you and your team have produced?
8. Is DT efficient with regard to time management?
    1. Is it efficient with regard to time management in the short term?
    2. Is it efficient with regard to time management in the medium to long term?

Appendix D

DT Phase	Observations of statements, collaborations and actions aligned to the corresponding 8 Design Abilities of Creative Problem Solvers
Navigate Ambiguity	
Learn from Others	
Synthesize Information	
Communicate Deliberately	
Move Between Concrete and Abstract	
Build and Craft Intentionally	
Design your Design Work	