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Cultivating 21st century skills: an exploratory case study of design thinking as a pedagogical strategy for elementary classrooms

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CULTIVATING 21ST CENTURY SKILLS: AN EXPLORATORY CASE STUDY OF DESIGN THINKING AS A PEDAGOGICAL STRATEGY FOR ELEMENTARY CLASSROOMS

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DEDICATION

This study is dedicated to my loving, supportive family, Gabe, Augustine, and baby-boy-VG-to-be. Thank you for your continuous encouragement and patience while I navigated this journey. I am beyond blessed to have you in my life. You have inspired me to keep pushing ahead to achieve my goals, and it is my hope I can always do the same for you.

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My chair, Dr. Davis, always ensured I was learning throughout this research process. When I experienced challenges with my research, she consistently took the time to make it a

learning moment. I truly appreciate her wisdom and expertise that helped shape how I approached my study.

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ABSTRACT

Research suggests pedagogical strategies with roots in constructivism can arm students with 21st century skills to prepare them for a successful future. While sufficient literature on constructivism exists, suggestions on formalized instructional approaches for applying theory to practice are limited. Design thinking is a process traditionally implemented in design and business industries to solve complex, ill-structured problems. As an instructional strategy, the design thinking process enables constructivist methodology in classrooms. This exploratory case study examines the process and outcomes of implementing design thinking as a pedagogical strategy in an elementary school classroom involving 25 third grade students and one teacher. The research explores the impact of design thinking on 21st century skills, which were characterized by the *Four Cs*: critical thinking, communication, collaboration, and creativity. The teacher and researcher partnered to design and implement a K-12 adapted design thinking framework for his classroom over a period of seven weeks. The design thinking framework laid the foundation for the instructional approach, while the design challenge was integrated into the third grade social studies curriculum. Sources of data included student group interviews, teacher interviews, student pre-post self-assessments, self-reflections, and researcher observations. Findings reveal the design thinking process as an engaging, curriculum-integrated constructivist approach that helps students successfully strengthen 21st century skills while addressing academic content. An analysis and triangulation of findings resulted in four conclusions: (a) design thinking is an effective instructional practice for elementary student learning of the Four Cs of 21st century skills; (b) design thinking presents opportunities for interactive, collaborative learning experiences where students are interested in the assignment; (c) design thinking involves a specific set of phases each that is essential to the process; and (d) design thinking

requires deliberate efforts from the teacher for successful classroom implementation**.** Educators are encouraged to consider design thinking as a pedagogical strategy to complement existing curriculum and aid classroom instruction. When integrated into academic content standards, design thinking supports students in acquiring content knowledge while developing 21st century skills. The research results contribute to existing literature by providing insights from the teacher and students while participating in a design thinking implementation in an elementary classroom.

Keywords: collaboration, constructivism, design thinking, four Cs, instructional strategy, 21st century skills

Chapter One: Introduction

Critical thinking, communication, collaboration, and creativity are terms commonly recognized in the modern classroom. Educators, organizational leaders, and policy makers claim these 21st century skills, known as the Four Cs, as critical skills for learners to acquire for success in the 21st century (National Education Association, 2012; Partnership for 21st Century Learning, 2015). It is considered that by fostering the development of the Four Cs, students would learn to innovate and master skills necessary for the demands of the current and future workforce (National Education Association, 2012; Trilling & Fadel, 2009).

Organizations have created instructional resources, such as skill-based frameworks or guides, in effort to support K-12 teachers in cultivating the development of 21st century skills. Instructional strategies with roots in constructivism have also been suggested (Kent & McNergney, 1999; Noweski et al., 2012; Scheer, Noweski, & Meinel, 2012). In particular, instructional strategies include project-based learning, problem-based learning, and design-based learning (Barrows, 1985; Kolodner et al., 2003; Pacific Policy Research Center, 2010; Prince, 2004; Rotherham & Willingham, 2009; Sawyer, 2005; Snape & Fox-Turnbull, 2011; Thomas, 2000). Research claims a more recent design-based strategy, design thinking, cultivates 21st century skills in education (Goldman, Kabayadondo, Royalty, Carroll, & Roth 2014; Noweski et al., 2012; Razzouk & Shute, 2012; Scheer et al., 2012).

History of 21st Century Learning

Presented well before the 21st century, "21st Century Learning" is a universal term in today's education and workforce. This term, coined to define skills necessary for the 21st century workforce, transpired as a result of a major economical shift. In 1991, the United States economy shifted from the Industrial Age to the Knowledge Age, when expenditures for the Knowledge

Age surpassed the Industrial Age by $5 billion (Trilling & Fadel, 2009). Instead of focusing on natural resources such as mining, or mass production and manufacturing of the Industrial Age, the economy became more reliant on intellectual capabilities, knowledge, and innovation such as information and communication technologies (Bereiter, 2002; Powell & Snellman, 2004; Trilling & Fadel, 2009). The Knowledge Age also introduced a more networked economy, which broadened these changes across the globe (Trilling & Fadel, 2009).

Economic trends such as automation, globalization, workplace environments, and personal risks have changed skills necessary for the workforce in the 21st century (Jerald, 2009). The evolved global economy requires people to do less routine cognitive and routine manual work and more complex communication and expert thinking as means to solve new problems (Levy & Murnane, 2007). Although most routine work may be automated, any remaining routine work moves to less developed countries where the cost of labor is low (Trilling & Fadel, 2009). Thus, developed countries require people to achieve more creative jobs such as work in research, global supply chain management, design, development, marketing, and sales (National Center on Education and the Economy, 2007).

Twenty-first century jobs require special skillsets, such as "The ability to quickly acquire and apply new knowledge, and the know-how to apply essential 21st century skills—problem solving, communication, teamwork, technology use, innovation" (Trilling & Fadel, 2009, p. 11). Many educational researchers argue the current U.S. educational system still functions similar to a factory model from the Industrial Revolution when the economy was designed for mass production (Bolstad & Gilbert, 2008; Gordon, 1998; Sawyer, 2005). It is apparent that addressing the concerns of a global, 21st century economy falls on the shoulders of the education system (Trilling & Fadel, 2009).

Developing 21st Century Skills in Education

Public schools, national education groups, higher education organizations, and workforce development groups recognize acquiring 21st century skills is crucial for students to succeed in today's workforce (Silva, 2009). Policy makers have also revised teaching and learning standards and assessments to acknowledge the importance of 21st century skills for students (Gewertz, 2008). In an effort to support implementation, several organizations have attempted to define 21st century learning. In 2007, a well-known organization amongst the21st century skills movement, the Partnership for 21st Century Learning, published a learning framework for 21st century skills. A subset of the framework, the Four Cs: critical thinking, communication, collaboration, and creativity, is often used in discussions to represent 21st century skills.

Educators strive to understand what 21st century learning should look like in classrooms. Although classrooms may decide to incorporate more technology or redesigned learning spaces, these changes focus on the environment and tools rather than the practical implementation. Educators still struggle to implement the ideas behind the 21st century skills movement (Holland, 2016). While organizations have created conceptual resources such as frameworks and taxonomies, these resources do not support practical implementation.

Researchers studying pedagogical science claim 21st century skills could be met with a constructivist approach to teaching (Kent & McNergney, 1999; Noweski et al., 2012; Scheer et al., 2012). As suggested by leading philosopher and educator, John Dewey (1916), learners need the opportunity to interact with the object and context in order to individually organize and build knowledge in a constructivist manner (Scheer et al., 2012). Although constructivism can nurture the development of 21st century skills, current research suggests it can be challenging for educators to implement since it is a theory rather than an instructional model (Gardner, 2009;

Scheer et al., 2012; Wagner, 2014). There is a missing link between what is understood to be effective pedagogy, supporting 21st century learning, and practical implementation (Scheer et al., 2012).

Literature presents project-based learning, problem-based learning, and design-based learning as instructional strategies for 21st century learning (Barrows, 1985; Kolodner et al., 2003; Pacific Policy Research Center, 2010; Prince, 2004; Rotherham & Willingham, 2009; Sawyer, 2005; Snape & Fox-Turnbull, 2011; Thomas, 2000). In project-based learning, students learn through inquiry and work collaboratively to research and create an authentic product (Bell, 2010). Problem-based learning focuses on solving authentic, ill-structured problems in a case study context (Barrows, 1985; Barrows, 2000; Ke, 2014; Savery, 2006). Design-based learning places students in meaningful contexts and asks them to use inquiry to design artifacts (Ke, 2014). With a recent emergence of design studies in education, design-based strategies are understudied. In particular, researchers claim the design strategy, design thinking, can help develop a mindset and the skills in demand of the 21st century (Noweski et al., 2012; Scheer et al., 2012).

Background of Design Thinking

Known to drive innovation, design thinking is a cognitive process and mindset (Luka, 2014) traditionally practiced in engineering and design fields as a method for solving complex problems. Design thinking has gained traction in business worlds to help design products and services (Dorst, 2011; Dunne & Martin, 2006; Martin, 2009), or even in healthcare to solve problems like maintain quality patient care during shift changes (Bate & Robert, 2007; Johnson et al., 2016; McCreary, 2010). The design thinking philosophy stems from the idea that ill-defined problems exist in every discipline and the process employed by designers, design

thinking, can be applied to any situation to problem solve or innovate (Carroll et al., 2010; Dorst, 2011; Gerber & Carroll, 2012).

Since the design research community values multiple perspectives and hesitates to oversimplify the complexity of design thinking, it is a challenging task to define the concept in a simple statement (Dorst, 2011). However, for the sake of clarity for this study, the definition presented by Tim Brown, the CEO of IDEO, who is an industry leader in design thinking, is used. Brown (2008) defines design thinking as follows:

> Unaffordable or unavailable health care, billions of people trying to live on just a few dollars a day, energy usage that outpaces the planet's ability to support it, education systems that fail many students, companies whose traditional markets are disrupted by new technologies or demographic shifts. These problems all have people at their heart. They require a human-centered, creative, iterative, and practical approach to finding the best ideas and ultimate solutions. Design thinking is just such an approach to innovation. (p. 92)

Design Thinking as Pedagogy for 21st Century Learning

Education has also embraced the design thinking approach for teaching critical innovative skills (Goldman et al., 2014; Noweski et al., 2012; Razzouk & Shute, 2012). As a design-based learning approach, research suggests design thinking practices constructivist methodology when employed as an instructional strategy (Noweski et al., 2012; Scheer et al., 2012). It is perceived as "a model for enhancing creativity, endurance, engagement, and innovation" (Dolak, Uebernickel, & Brenner, 2013, p. 2). Although implementing design challenges in academia has been discussed for over thirty years by influential thinkers such as Donald Schön (1983), it has more recently gained recognition as a strategy for supporting STEAM (Science Technology Engineering Arts Math) or Makerspace initiatives (Berland et al., 2013; Bowler, 2014; Casey, Hastie, & Rovegno, 2011; Jarrett, 2016; Rice, 2011). Makerspaces are physical places where learners are encouraged to collaborate, create, and innovate by using a

hands-on approach with technology and different mediums of the arts (Bowler, 2014). However, educationalists argue design thinking can be applied to any discipline as a way to deal with complex problems that may dominate any aspect of our society (Gardner, 2009; Pink, 2006). In particular, studies highlight design thinking as a tool for fostering 21st century skills such as collaboration (Kangas, Seitamaa-Hakkarainen, & Hakkarainen, 2013; Kolodner et al., 2003), creativity (Barlex & Trebell, 2008; Gerber & Carroll, 2012), and higher-order thinking (Schooler, 2004).

In an effort to support teachers in practical implementation, several organizations have defined strategies for including design thinking into education. In 2012, IDEO published *Design Thinking for Educators* as a guide for helping K-12 educators conduct design thinking activities. The design thinking process presented in this resource reflects similar processes applied in many business settings. Stanford University is home to several design thinking organizations such as the Hasso Plattner Institute of Design (d.school), REDlab, and K-12 Lab Network. Each of these organizations contributes to the design thinking education community by continually publishing resources and studies. A more recent project by two educators, Spencer and Juliani (2016), is called the LAUNCH Cycle, which offers a guide for implementing design thinking in K-12 classrooms. The LAUNCH Cycle framework adapts the design thinking process into phases and terms suitable for K-12 contexts.

Problem Statement

Research highlights the significance of using instructional strategies in order to cultivate 21st century skills in preparation for the current and future workforce (Noweski et al., 2012; Scheer et al., 2012). Resources to support educators have been limited to opinions, standards, taxonomies, theory, and guidelines. Research about effective pedagogical frameworks to support

these skills in an elementary context is limited. In particular, research around design-based strategies, such as design thinking, is limited. If applied as an instructional strategy, design thinking can be implemented within any part of an existing curriculum, not just STEAM or Makerspace initiatives. Design thinking can provide educators with a flexible instructional strategy to cultivate 21st century skills within their curriculum. Through a teacher-researcher partnership, this study provides an opportunity to explore design thinking as a pedagogical strategy in elementary classrooms.

Purpose of Research

The purpose of this exploratory case study is to explore the process and outcomes of implementing a design thinking process into learning activities within an existing curriculum for students in an elementary school classroom. A third-grade teacher partnered with the researcher to implement the design thinking process in his classroom. For the purpose of this study, design thinking is defined as "…a human-centered, creative, iterative, and practical approach to finding the best ideas and ultimate solutions" (Brown, 2008, p. 92). The results of this study explore integrating the design thinking process as a pedagogical framework into existing curriculum as a way to cultivate students' 21st century skill development. To provide a workable definition, the 21st century skills are recognized as the Four Cs: critical thinking, communication, collaboration, and creativity (Partnership for 21st Century Learning, 2015). Results also explore practical strategies for implementing design thinking in classrooms.

Research question. This study asks the following central research question:

- How does implementing the design thinking process into learning activities with elementary school-aged children foster the development of critical thinking, communication, collaboration, and creativity?

To explore the central research question, the sub-questions include:

- Questions Related to Student Participants
    1. What does it look like for students to engage in design thinking learning activities in the classroom?
    2. How do students perceive design thinking learning activities?
    3. Do students demonstrate critical thinking, communication, collaboration, and creativity skills while participating in design thinking learning activities? If so, how?
- Questions Related to the Teacher Participant
    1. How does the involved educator believe the use of design thinking contributes to the acquisition of critical thinking, communication, collaboration, and creativity in an elementary school classroom?
    2. What challenges are anticipated by the educator for implementing design thinking within instructional plans?

Conceptual Framework and Definition of Terms

Two conceptual areas frame this study. The first concept is 21st century learning, characterized by the Four Cs, and how students acquire the skills necessary for success in the future. The second concept is design thinking and how this process impacts student learning, namely how it facilitates 21st century skills. In order to present clarity and consistency, definitions are organized by each conceptual area.

Terms associated with 21st century learning include the following:

- Collaboration: The ability to work effectively in diverse teams, exercise flexibility, and assume a shared responsibility while valuing individual contributions (Partnership for 21st Century Learning, 2015).
- Communication: The ability to articulate thoughts and ideas and listen effectively using multiple media and technologies in diverse environments (Partnership for 21st Century Learning, 2015).
- Constructivism: A learning theory in which learners experience an active process of making their own individual meanings through knowledge construction (Piaget, 1952).
- Creativity: The ability to exercise idea creation techniques, create ideas, analyze and refine ideas, work creatively with others, and implement (Partnership for 21st Century Learning, 2015).
- Critical thinking: The ability to reason effectively, use systems thinking, make judgments and decisions, and solve problems (Partnership for 21st Century Learning, 2015).
- Design-based learning: Students problem solve by applying a formal design process to create an artifact (Ke, 2014).
- Four Cs: Critical thinking, communication, collaboration, and creativity (Partnership for 21st Century Learning, 2015).
- Problem-based learning: Focuses on solving authentic, ill-structured problems in a case study context (Barrows, 1985; Barrows, 2000; Ke, 2014; Savery, 2006).

- Project-based learning: An innovative approach where students learn through inquiry and work collaboratively to research and create an authentic product (Bell, 2010).
- 21st century skills: The skills, expertise, and knowledge students should learn in order to succeed in work and life; a mix of specific skills, content knowledge, and literacies (Partnership for 21st Century Learning, 2015).

Terms associated with design thinking include the following:

- Design thinking: "A human-centered, creative, iterative, and practical approach to finding the best ideas and ultimate solutions" (Brown, 2008, p. 92).
- Design thinking process: The steps in which designers create, gather feedback, and iterate (Razzouk & Shute, 2012). The steps include: empathize, define, ideate, prototype, and test (Hasso Plattner Institute of Design, 2010).

The Organization and Setting

The case study involved 25 students and their teacher from a third grade classroom located in San Francisco Bay Area, California. The primary source of data came from the students participating in the design thinking challenge during the fall of 2018. As the teacher was thoroughly engaged in the development and implementation of the lessons involved in the study, his perspective and interactions with students provide relevant and important data. This population was chosen due to the unique amount of collaboration required by the teacher participating in this study. The duration of the study, from pre-study preparation with the teacher to the last lesson implementation, occurred over a three-month period.

Role as the researcher. The researcher practiced reflexivity as a method for acknowledging any potential bias and to situate within the study (Creswell, 2007, 2014). The researcher's experiences as a former elementary school teacher, curriculum designer, and

professional learning facilitator have led the researcher to become interested in exploring effective pedagogical strategies for teachers. Specifically, the researcher is interested in strategies that can be implemented within a teacher's existing curriculum, rather than strategies that must be tied to a particular discipline or skill.

Personal experiences have led the researcher to believe that professional learning opportunities for teachers, when they are available, are not always valuable. Often, "out of the box" solutions, which combine content and strategy, are presented. This can be an issue as these solutions may not compliment a teacher's existing curriculum and may add to his or her workload. It is the researcher's belief that intentional instructional strategies can help teachers focus on traditional subjects while developing important competencies, such as the Four Cs. Thus, research around effective instructional strategies, especially for a changing 21st century economy, would greatly benefit a teacher's toolbox. The researcher believes by exploring effective instructional strategies, such as design thinking, teachers may discover tools for strengthening learning activities within their existing curriculum.

The researcher engaged in the classroom through the lens of a researcher. Although this study is considered backyard research (Glesne & Peshkin, 1992), the researcher's former relationship with the participating teacher did not impact the data. While the researcher did not teach at this school site, the school's demographic is similar to her previous experiences. Multiple validation strategies were exercised in order to ensure accuracy of information and lack of bias (Creswell, 2014). Additionally, the researcher ensured the privacy and confidentiality of participants and the school. The researcher employed strategies to view data from both teacher and student lenses upon data analysis.

Assumptions and limitations. Several assumptions and limitations were considered for this study. This study assumed the teacher and students offered credible information by answering questions openly and honestly. The confidentiality between researcher and participant gave participants assurance they were not mistreated. Another assumption is the teacher participant's facilitation strategies during design thinking activities represented teaching best practices.

This study was limited to a teacher and students in a third grade public school classroom in San Francisco Bay Area, California. Since the sample was small, results cannot be generalized across all elementary school classrooms. While this study does not accommodate generalizations for broader classroom contexts, the results can be used to inform teachers on the process and outcomes of implementing design thinking in elementary classrooms. Another limitation is the self-reported assessment data from students. The researcher worked under the assumption that students understood the questions being asked, and students answered honestly without worrying about their images.

Significance of the Study

Literature reveals instructional strategies with roots in constructivism can be employed in K-12 classrooms to foster the development of 21st century skills (Kent & McNergney, 1999; Noweski et al., 2012; Scheer et al., 2012). While methodologies such as project-based and problem-based learning are more commonly practiced, design-based strategies need further investigation. Design thinking is recognized as an effective instructional strategy for 21st century skill development (Noweski et al., 2012; Scheer et al., 2012). However, design thinking is most commonly linked to STEAM initiatives in middle or high school contexts (Berland et al., 2013; Bowler, 2014; Casey et al., 2011; Jarrett, 2016; Rice, 2011). It is also unclear how a design

thinking implementation may unfold in classrooms (Kimbell, 2011; Lahey, 2017). While resources for design thinking are helpful, they do not reveal the process of implementing design thinking into existing curriculum.

The goal of this study is to contribute to educators' understanding of design thinking as an instructional strategy by offering a case study example. Results may also inform practices for professional learning about design thinking in schools. The term professional learning is used purposefully as this trend is replacing professional development in schools. Teachers are encouraged, and sometimes required, to continually evolve their teaching practices. The study reveals practical knowledge for implementing design thinking into an existing curriculum in any discipline. The practical knowledge may inform both classroom teachers and professional learning programs. The case study is particularly meaningful for lower elementary classrooms. Additionally, results provide guidance for 21st century skill development, adding to the literature on 21st century skills.

Summary

This study focused on the experiences of students and their teacher who participated in a design thinking challenge through a classroom implementation. Both teacher and student insights provide data about the outcomes of design thinking as an instructional strategy. This study comes at a time when it is important to define different instructional strategies for 21st century skill development. This case study presents information that broadens the understanding of curricular-integrated design thinking approach in an elementary classroom context, and its impact on 21st century skill development.

Chapter Two: Literature Review

Economic and technological advances are changing the way we work. Studies show the importance of developing skills required for the future workforce, which are often described as 21st century skills (Jerald, 2009; Trilling & Fadel, 2009). In order to prepare students for the future, educators must focus on cultivating 21st century skills (National Education Association, 2012). This chapter presents the research behind the 21st century skills movement in education and arrives to a definition of 21st century skills for this study. Next, research on educational theory and strategies to foster these skills is presented. As a result of the research, design thinking is proposed as a design-based learning approach to nurture skills necessary for the 21st century. Thus, a history of design thinking and contemporary design thinking is presented, along with a definition and applications of design thinking in education.

Foundations of 21st Century Skills

The 21st century skills movement began decades ago as a result of research that revealed the current and future workforce required alternative skills to be successful in the evolving globalized and technology-driven economy (Jerald, 2009; Trilling & Fadel, 2009). Researchers refer to this economical shift as the Knowledge Age or Knowledge Economy, when value shifted from manufacturing and assembly, to data, information, knowledge, expertise, and services (Bereiter, 2002; Drucker, 1993; Trilling & Fadel, 2009). In their book on 21st century skills, Trilling and Fadel (2009) explained the knowledge economy turns expertise, technology, and information into necessary services such as health care or cellular coverage. From his personal research, Bereiter (2002) called for an education reform, claiming society needs more knowledge production. In a paper, Drucker (1993) presented 21st century skills from a historical and political lens as he explained knowledge as the basic economic resource. In a review of research, Jerald

(2009) highlighted automation, globalization, workplace change, and personal risk, as economic trends shaping the skills critical for our future workforce.

Computer automation, the first presented trend, is changing the way we work. In a research paper reporting on economic trends, widely recognized economists, Levy and Murnane (2007), explained how computers both substitute and complement human skills. Computers are accomplishing a wide range of tasks such as work-related thinking, and are increasingly completing what Levy and Murnane (2007) referred to as routine work (Jerald, 2009; Trilling & Fadel, 2009). Routine work consists of manual and cognitive tasks that are rules-based, repetitive, or procedural; this type of work is either becoming more automated or moving to countries where labor cost is low (Levy & Murnane, 2007; Trilling & Fadel, 2009).

Consequently, economists urge for skills to be developed to strengthen non-routine tasks, categorized under expert thinking and complex communication (Levy & Murnane, 2007). Levy and Murnane (2007) defined expert thinking as the ability to solve unexpected problems that do not have predicable, rule-based solutions. Complex communication can be thought of as the process of acquiring or explaining information through interactions with other people (Levy & Murnane, 2007). In another report of economic research, Levy and Murnane (2013) summarized jobs such as teaching, selling, managing, or nursing, as requiring non-routine tasks. As a certain amount of domain knowledge is necessary for these professions, individuals should be able to exchange a particular understanding of information, not just information. Tasks requiring expert thinking and complex communication cannot be automated using technology, thus these skills should be strengthened in order to compete in the 21st century workforce.

Globalization is another trend shaping the future skills demands (Friedman, 2005; Jerald, 2009; Levy & Murnane, 2007, 2013; Trilling & Fadel, 2009). Advancement in technology has

created a more connected world where economic, social, and intellectual barriers have diminished (Jerald, 2009). In his well-known book, New York Times columnist, Friedman (2005), explained how advancements in telecommunications and the Internet have flattened the playing field, as Americans are faced with more competition for higher skilled jobs. Geographic distance is no longer an issue as people can collaborate more easily. In an influential paper, Harvard economist, Freeman (2007), added that historic political changes have freed people in several countries, resulting in what he called The Great Doubling, meaning a significant increase in the global workforce.

Globalization is affecting the 21st century skills demand in multiple ways. First, individuals will need to develop sufficient skills and education to compete for good jobs (Jerald, 2009). Americans will need to compete for higher skilled jobs since the lower skilled jobs will be outsourced (Jerald, 2009; Levy & Murnane, 2007; Trilling & Fadel, 2009). Additionally, a more connected world affects the type of knowledge and skills necessary to succeed, such as global literacy. In his book, Burniske (2000) defined global literacy as the ability to read, analyze, answer, and contextualize communication from a global perspective. Researchers agree communication skills and global literacy are becoming more valued as collaboration is increasing, specifically outside of the U.S. (Burniske, 2000; Jerald, 2009; Trilling & Fadel, 2009).

Another trend shaping 21st century skills is a changing workplace (Jerald, 2009; O'Toole & Lawler, 2007; Wagner, 2014). In their book based on research, O'Toole and Lawler (2007) examined factors contributing to the changing workforce and discussed the impact on future workplaces. O'Toole and Lawler (2007) presented themes from their research analysis about the American workplace, such as insufficient creation of new good jobs, increased choice and risk,

and the changing nature of careers. In his widely recognized book, education expert Wagner (2014) explained workplace environments have changed as organizations are continuing to be flattened; there is less hierarchy and supervision. Thus, the organizational freedom allows employees to have more autonomy and responsibility (O'Toole & Lawler, 2007; Wagner, 2014). A more flattened organization has also led to the increase of cross-functional teams and networks (O'Toole & Lawler, 2007; Wagner, 2014). Friedman's (2005) concept of flatteners supports how these team members collaborate virtually and globally. Additionally, what was once recognized as a traditional job has transformed. Instead of job titles and longevity, companies focus on specialties or work assignment descriptions (O'Toole & Lawler, 2007). It is required of employees to continually update and develop skills on their own to succeed (O'Toole & Lawler, 2007). In a speech about education and globalization, UPS CEO Eskew (2005), confirmed the importance for people to be able to learn how to learn when there is so much uncertainty about the future.

Changes in workplace environments are impacting the skills demands in a variety of ways. Jerald (2009) emphasized less supervision in a flattened organization requires individuals to work in greater autonomy and problem solve independently. Additionally, strong written, oral, and social interpersonal skills are required to collaborate amongst teams. Global literacy is emphasized (Burniske, 2000; Jerald, 2009; Trilling & Fadel, 2009), as these teams will continue to naturally grow globally. Last, Jerald's (2009) review of research reported the ability to learn new skills and adapt to company changes as important skills for career success.

The final discussed trend impacting skills required of the current and future workforce is personal risk and responsibility related to job security, health care, and financial planning (Jerald, 2009; O'Toole & Lawler, 2007). In their research, O'Toole and Lawler (2007) found employers

valued job performance as the key indicator for continued employment. Loyalty and longevity are no longer at the heart of continued employment as previous research revealed (O'Toole & Lawler, 2007). Additionally, in a report of research, Munnell, Haverstick, & Sanzenbacher (2006) explained the offer of pension plans to employees had dropped from 60% to 11%. Thus, it is becoming more important for individuals to become increasingly responsible for their own future security and retirement.

In a research paper on financial literacy, Lusardi (2008) reported a large group of U.S. citizens, particularly those with low education, demonstrated financial illiteracy. Similar trends have been reported for health care, where coverage choices are complicated and patients are required to contribute more to medical expenses. In a summary of three studies on quality information in healthcare, Hibbard, Peters, Dixon, and Tusler (2007) found healthcare information presented to consumers as difficult to understand, especially anything regarding ratios. Safeer and Keenan (2005) furthered this point in a paper addressing the need to increase public awareness about health literacy.

Jerald (2009) described the environment as becoming more complex which requires individuals to take greater risks. In order to retain jobs, individuals will need to continue developing new skills (O'Toole & Lawler, 2007). Strong reading and mathematical skills are important for managing personal responsibilities related to people's jobs, finances, and healthcare. In a report of research, economists Carnevale and Desrochers (2003) claimed the way students learn math skills in school do not align with how these skills are applied on the job. Students will need to apply the practical literacies and competencies they learn in school in order to make important decisions for their well-being and future (Jerald, 2009; National Center on Education and the Economy, 2007). In *The Report on the New Commissions on the Skills of the*

American Workforce, the National Center on Education and the Economy (2007) described a broader set of skills, such as collaboration and creativity, as necessary skills for Americans to succeed. Jerald (2009) described these practical literacies as the ability to draw on the other academic and real-world skills.

The trends discussed in this section highlight several studies that serve as the foundation of what has come to be known as 21st Century Skills. These broader skills, twenty first century skills, are additional skills that complement skills and content knowledge acquired through traditional subjects (National Center on Education and the Economy, 2007). However, research reports foundational subjects such as English or Mathematics are still important, as they are necessary for students to achieve promising jobs or succeed in higher education (American Diploma Project, 2004; Hanushek & Woessmann, 2008; Partnership for 21st Century Learning, 2015; Rose & Betts, 2004).

In an analysis of high school math data, Rose and Betts (2004) found success in high school traditional courses impact a person's economic returns in the future. Hanushek and Woessmann (2008) in a review of empirical data found cognitive skills gained in traditional school subjects had powerful effects on individual earnings. The American Diploma Project (2004) suggested that all students pursuing college or a career should enter with the same level of foundational skills, in subjects such as Math or English. The Partnership for 21st Century Learning (2015), as discussed later in this chapter, included traditional subjects as part of their framework for 21st century skills. As suggested, in addition to traditional subjects, these broader skills and literacies are required in a world of globalization, automation, workplace changes, and personal responsibilities (Jerald, 2009; National Center on Education and the Economy, 2007).

Therefore, researchers such as Miller (2007) have suggested developing a well-educated workforce relied on what happens in the classroom.

21st century skills in the classroom. As we are up against economic, social, and environmental changes, education is critical now more than ever. In a book presenting data from empirical studies, the National Research Council (2012) suggested it is important to define a deeper set of skills for learning in the 21st century. Research furthers this notion by suggesting skills necessary for the Knowledge Age are much different than what was necessary in the Industrial Age (Snape & Fox-Turnbull, 2011; Trilling & Fadel, 2009).

Trilling and Fadel (2009) suggested goals for education have evolved from the Agrarian Age, to the Industrial Age, to the Knowledge Age. In the Agrarian Age, people focused on learning how to grow food for their family, so goals focused on working in fields and helping neighbors (Trilling & Fadel, 2009). In the Industrial Age, goals focused on standardization, mass production, and uniformity as people moved from fields to factories (Trilling & Fadel, 2009). Transitioning to the Knowledge Age means a flat, connected world where education goals focus on brainpower, communication, and collaboration (Trilling & Fadel, 2009). For example, Trilling and Fadel (2009) argued a goal of the Industrial Age as "serve society through a specialized profession knowledge work," (p. 14) and in contrast the Knowledge Age is focused on "contributing to the global information and innovation…" (p. 14).

Many educationalists have argued schools are stuck in ways from the Industrial Age (Bolstad & Gilbert, 2008; Gordon, 1998; Sawyer, 2005). Bolstad and Gilbert (2008) in their book proposing new school models explained during the Industrial Revolution the factory model practiced in schools was influenced by standardization, mass production, and uniformity in order to supply human resources for the economy. In a paper on authentic learning, Gordon (1998)

confirmed this idea by describing instead of engaging in authentic learning situations, students sat dead in rows in a graveyard model of teaching.

In a book on learning sciences, Sawyer (2005) described the design of school as a transmission of knowledge (as facts) and procedures, with the inclusion of tests to measure success. For example, the ability to follow directions was once viewed as an important objective for the twentieth century (Bellanca & Brandt, 2010; Levy & Murnane, 2013). In their book, Bellanca and Brandt (2010) explained although once important, more complex skills are required of workers than the ability to just follow directions. Levy and Murnane (2013) furthered this idea by stating following a simple direction was a shortcut for completing tasks without focusing on the process; a skill emphasized in the 21st century. Sawyer (2005) further explained studies in the learning sciences revealed how schools, as they were designed during the Industrial Revolution, were not designed around any founded research. This traditional approach to school is often referred to what the prominent educational theorist Papert (1980), coined as instructionism.

Educationalists call for different approaches and methods of teaching to foster skills necessary for the 21st century (Claxton, 2007; Sawyer, 2005; Snape & Fox-Turnbull, 2012; Wagner, 2014; Wrigley & Straker, 2017). In a report of research, Claxton (2007) called for different learning capacities and systemic changes. In their paper, Snape and Fox-Turnbull (2012) suggested an evolvement in teaching and learning methodology, particularly technology education, as necessary for students to thrive in the 21st century. In an empirical study, Wrigley and Straker (2017) emphasized different learning processes should be practiced in order to cultivate new skills and attitudes newly valued by schools and companies.

Wagner (2014) described the gap between what the best schools are teaching and what students need to succeed in today's global 21st century economy as The Global Achievement

Gap. In his book based on economic data, Wagner (2014) advocated for the following seven survival skills to aid 21st century learners: (a) critical thinking and problem solving, (b) collaboration across networks and learning by influence, (c) agility and adaptability, (d) initiative and entrepreneurialism, and (e) effective oral and written communication.

Trilling and Fadel (2009) concluded reports from around the world revealed students graduating from school were not ready for the workforce. Their conclusion combined with other writings from the U.S. based National Center on Education and the Economy (2007) suggest students need to be prepared for the non-routine, high paying jobs where creative work is necessary. In 2007, Claxton advocated for an epistemic culture shift focusing on the process of learning and changing learning dispositions. A 21st century education should establish a generic capacity and desire to learn. He explained in order to understand the skills necessary for the 21st century, it was important to arrive to a definition on 21st century skills (Claxton, 2007).

Defining 21st century skills. In an article on 21st century skills, Silva (2009) expressed the "21st Century" label was often vague, confusing, or convoluted. Her work focused on designing assessments for measuring skills of the 21st century. Silva (2009) argued these skills were not new as they could be found in early writings of famous ancient philosophers, such as Socrates or Plato. She also expressed the skills as reflective of the progressive education movement, such as leading philosopher and educator Dewey (1916), whose work focused on the importance of participating in real world learning experiences.

In a theoretical discussion, Rotherham and Willingham (2009) proclaimed critical thinking, recognized as a 21st century skill, has shown importance throughout history as humans have developed from using early tools, to agricultural tools, to land exploration. Thus, the 21st Century label could be misleading as these skills have proved to be important for every century.

Silva (2009) declared, "21st-century skills, then, are not new, just newly important" (p. 631). Rotherham and Willingham (2009) suggested although the skills may not be new, defining 21st century skills could help schools become more deliberate about integrating them into their curriculum.

Over the past few decades, several organizations have attempted to define the broader competencies, or sometimes referred to as literacies, or skills, necessary for the success of individuals in the 21st century. The debate on the definition of 21st century skills may also stem from the hundreds of descriptions and frameworks attached to this term. Unfortunately, buzzwords and flashy phrases are often used when trying to define 21st century skills (Silva, 2009). In order to arrive to a targeted definition for this study, this section previews various frameworks for 21st century skills.

The Metiri Group and North Central Regional Educational Laboratory (NCREL) produced a framework in 2003, known as the enGauge framework. The categories for the framework consist of the following: (a) digital age literacy; (b) inventive thinking; (c) effective communication; and (d) high productivity (Metiri Group & NCREL, 2003). In 2005, a framework was produced by the Organization for Economic Co-operation and Development (OECD), consisting of three categories: (a) using language, symbols, and texts interactively; (b) managing and resolving conflicts; and (c) acting autonomously. In their review of frameworks, Bellanca and Brandt (2010) explained both the enGauge framework and the OECD competencies focused on new contextual skills rather than weaving them with skills of the twentieth century.

The National Leadership Council for Liberal Education and America's Promise Essential Learning Outcomes (LEAP) developed a framework in 2007 presenting 21st century skills expected of higher education graduates, in hopes to serve as a foundation for K-12 education

(Bellanca & Brandt, 2010). Categories for the LEAP framework include: (a) knowledge of human cultures and the physical and natural world, (b) intellectual and practical skills, (c) personal and social responsibility, and (d) integrative learning (National Leadership Council for Liberal Education and America's Promise, 2007).

In 2013, the National Council of Teachers of English's (NCTE's) published a domain-focused framework, the Framework for 21st Century Curriculum and Assessment (NCTE, 2013). This framework describes 21st century literacies that should be applied to English Language Arts in order to prepare students for a 21st century global society. The literacies include: (a) develop proficiency and fluency with the tools of technology; (b) build intentional cross-cultural connections and relationships with others so to pose and solve problems collaboratively and strengthen independent thought; (c) design and share information for global communities to meet a variety of purposes; (d) manage, analyze, and synthesize multiple streams of simultaneous information; (e) create, critique, analyze, and evaluate multimedia texts; and (f) attend to the ethical responsibilities required by these complex environments.

In 2007, The International Society for Technology in Education (ISTE) revised its standards for students to include 21st century skills. The following ISTE (2007) standards are particularly relevant to this study:

- Creativity and innovation: Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology.
- Communication and collaboration: Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others.

- Critical thinking, problem solving, and decision making: Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources (paras. 1-4).

Partnership for 21st century learning. One of the most influential organizations, recognized by researchers and educationalists alike, for supporting 21st century learning is the Partnership for 21st Century Learning (Bellanca & Brandt, 2010; Larson & Miller, 2011; Pacific Policy Research Center, 2010; Snape & Fox-Turnbull, 2011; Trilling & Fadel, 2009). Trilling and Fadel (2009) described the Partnership for 21st Century Learning as powered by a consortium of global high-tech companies, innovative educational for-profit companies, and non-profit educational organizations. The Partnership for 21st Century Learning was founded by several organizations such as America Online Time Warner Foundation, Apple Computer, Inc., Cable in the Classroom, Cisco Systems, Inc., Dell Computer Corporation, Microsoft Corporation, National Education Association, U.S. Department of Education, and individual members, Ken Kay and Diny Golder-Dardis (Partnership for 21st Century Learning, 2015).

The Partnership for 21st Century Learning is notable for conducting research on 21st century skills in education, creating educational resources, and strategizing to sustain the educational 21st century skills agenda. However, the organization is best known for its framework on 21st century skills. The Partnership for 21st Century Learning Framework, as well as several ancillary publications, provides detail and direction on 21st century skills in schools. Thus, Dede (2009) described this framework as more widely adopted than others. Resources for educators include, but are not limited to: 21st Century Standards, Assessments of 21st Century Skills, 21st Century Curriculum and Instruction, 21st Century Professional Development, and 21st Century Learning Environments (Partnership for 21st Century Learning, 2015).

While the Partnership for 21st Century Learning is prominent in the 21st century skills movement, it is important to address a historical discussion by skeptics. Endorsements from several influential businesses within the technology field have lead skeptics to question the organization's motives. Some claim the non-profit is as an attempt for technology companies to gain influence in classrooms (Sawchuk, 2009). Critics have also questioned the birth of the Partnership for 21st Century Learning, as the non-profit began in 2002 with backing from the U.S. Department of Education (Sawchuk, 2009). However, the debate extends much further than the organization itself. Education has seen its fair share of fads, and the question of whether the 21st century movement would become one of them is nothing new (Mathews, 2009; Munson & Bornfreund, 2010). Unfortunately, the Partnership for 21st Century Learning as well as similar organizations, are situated in a much larger educational debate.

Despite the debate, supporters such as the National Education Association (NEA) and National School Boards Association (NSBA), have helped popularize the movement and the Partnership for 21st Century Learning in particular, as an advocacy group for skills development and technology integration in schools (Sawchuk, 2009; Stevens, 2011). Ken Kay, the non-profit's CEO, described its business connections as the key to informing research on skills required for a globalized workforce (Sawchuk, 2009). Policy makers have also encouraged focusing on 21st century skills in schools (Partnership for 21st Century Learning, 2008; Sawchuk, 2009). While there is much discussion around 21st century skills, educationalists can agree that new, advanced skills are necessary for our current and future workforce. At present, the 21st century movement is a way to conceptualize these skills and assert a critical discussion. Further, the Partnership for 21st Century Learning continues to be a leader in sustaining the agenda due to the detailed, widespread applicability of its framework.

The partnership for 21st century learning framework. The Partnership for 21st Century Learning Framework "describes the skills, knowledge and expertise students must master to succeed in work and life; it is a blend of content knowledge, specific skills, expertise, and literacies" (Partnership for 21st Century Learning, 2015, p. 1). The framework categorizes four areas of skills necessary for students in the 21st century (see Figure 1). The framework suggests students should master Key Subjects such as English, World Languages, Arts, Mathematics, Economics, Science, Geography, History, and Government and Civics. Additionally, schools should weave in global awareness, business literacy, civic literacy, health literacy, and environmental literacy. Learning and Innovation Skills is the second category identified by the framework. These skills are commonly referred to as the Four Cs: creativity and innovation, critical thinking and problem solving, communication, and collaboration.

The third category is Information, Media, and Technology Skills. The Partnership for 21st Century Learning (2015) recognizes in a technology and media-driven economy, students should develop skills in the following: information literacy, media literacy, and Information and Communications Technology (ICT) literacy. The last category is titled Life and Career Skills, which describes students should master skills such as flexibility and adaptability, initiative and self-direction, social and cross-cultural skills, productivity and accountability, and leadership and responsibility.

Although the framework presents several categories, practitioners lean on the Four Cs: critical thinking, communication, collaboration, and creativity, from Learning and Innovation Skills to define 21st century skills. In an article, Saxena (2014) referred to the Four Cs as super skills for the 21st century. In his research, Kivunja (2015) described the Four Cs as essential for success in the 21st century and digital economy. No matter the framework educators choose to

incorporate, the Four Cs shares skills in common with several 21st century frameworks. While the best, most accurate definition for 21st century skills is undecided, this study utilizes the Partnership for 21st Century Learning's Four Cs to characterize 21st century skills, due to its global recognition and widespread use in education.

The Four Cs. While the Partnership for 21st Century Learning's (2015) Framework for 21st Century Learning is comprehensive, the National Education Association (2012) reported educators originally claimed it to be complicated and long. In effort to make the framework more consumable, the Partnership for 21st Century Learning interviewed leaders to determine the most important skills, which became known as the Four Cs: critical thinking, communication, collaboration, and creativity (National Education Association, 2012). Trilling and Fadel (2009) described these four skills as the "keys to unlocking a lifetime of learning and creative work" (p. 49).

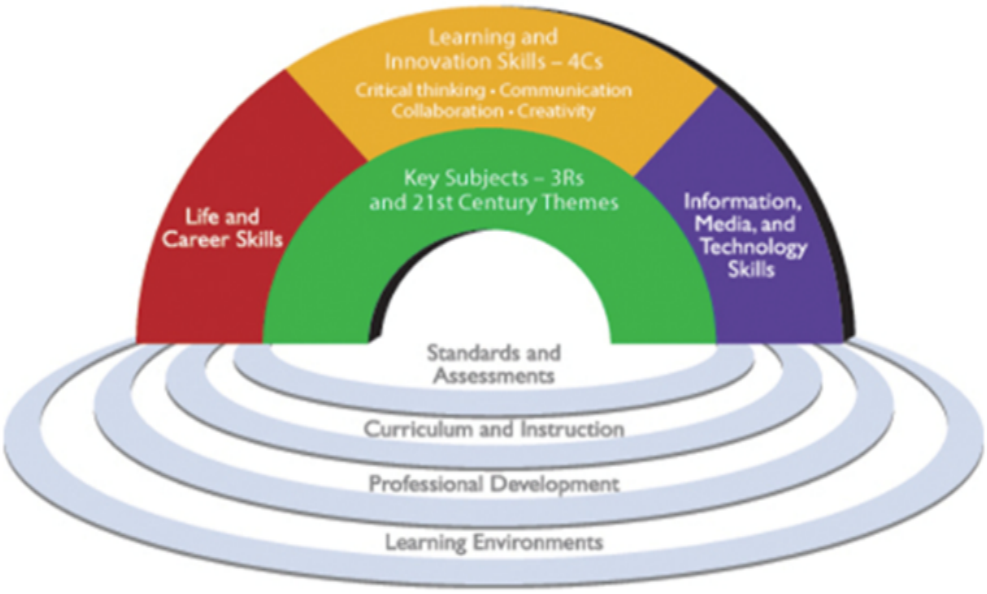


Figure 1. P21 Framework for 21st Century Learning. From "Framework for 21st Century Learning" by Partnership for 21st Century Learning, 2016. Reprinted with permission.

While the skills within the Four Cs are often described separately, they are designed to work together (Jerald, 2009; Partnership for 21st Century Learning, 2015). It is not unusual to see these skills discussed in combination. In her review of literature, Lai (2011) presented several researchers drawing connections between critical thinking and creativity. She summarized work from Bailin (2002) who argued that creativity is required for critical thought. In a paper discussing her work with children, Seefeldt (2004) found collaboration and communication go hand-in-hand. Furthering this concept, Kafai (2002) found in a study with elementary students oral communication and collaborative skills are important together in order for students to express thought and share ideas. Defining these skills is important in order for school districts to intentionally focus on embedding these in their curriculum (Jerald, 2009). Rotherham and Willingham (2009) extended this idea by arguing improved curriculum promoting the development of intertwined skills and knowledge as necessary for the 21st century movement.

Critical thinking. The Partnership for 21st Century Learning (2015) organizes critical thinking into four buckets, proposing students should be able to: (a) reason effectively: apply types of reasoning such as inductive and deductive to different situations; (b) use systems thinking: evaluate how parts of a whole work together; (c) make judgments and decisions: analyze evidence, arguments, claims, and beliefs; make connections and interpret information; reflect on experiences; (d) solve problems: use conventional and innovative ways to problem solve; ask clarifying questions. In their guide to the Four Cs, the National Education Association (2012) suggested connecting critical thinking to the other Cs as paramount, especially its connection to creativity. The Pacific Policy Research Center (2010), in a 21st century literature review described in the world of Web 2.0, thinking critically meant individuals should apply creative thinking to technology while collaborating with people from a variety of backgrounds.

In research conducted by the Conference Board (2006), nearly 60% of employers ranked critical thinking as very important for students entering the workforce. As a long time valued skill in education and society, critical thinking contributes to success in careers and higher education (Jerald, 2009). In a paper, cognitive scientist Willingham (2007) described critical thinking as: reasoning, making judgments and decisions, and problem solving. The National Research Council (2000) suggested critical thinking meant having a rich body of knowledge, or expertise, on subject matter, complementing Levy and Murnane's (2007) concept of expert thinking.

Students need deep knowledge of core subjects in order to analyze and exercise critical thinking skills (Resnick & Hall, 1998; Willingham, 2008). Resnick and Hall (1998) referred to this as knowledge-based constructivism in a discussion about education reform. In a discussion on expertise, Willingham (2007) proclaimed critical thinking required the ability to exercise domain knowledge. For example, in his famous study on expertise, DeGroot (1965) declared experts have a skillset to recognize meaningful patterns of information in a domain. Patterns are organized by what the seminal educational theorist Piaget (1952) described as schemas, which allows experts to recognize patterns and problem solve (Jerald, 2009). As supported by current research, the Partnership for 21st Century Learning has retained a category on mastering subject matter within their framework.

Communication. The Partnership for 21st Century Learning (2015) defines communication as the ability to: (a) articulate thoughts and ideas using written, oral, and nonverbal skills; (b) listen to decipher meanings; (c) communicate for a range of purposes such as instruct, motivate, and inform; (d) use and assess impact of media and technology; and (e) communicate in diverse environments. Communication and collaboration are often tied together

as these skills are necessary and developed by working effectively in diverse teams (Jerald, 2009; Trilling & Fadel, 2009). In their research, both Jerald (2009) and Trilling and Fadel (2009) presented these skills together instead of separately.

In a study by the Conference Board (2006) comparing interpersonal skills, employers revealed written and oral communications as both very important yet entrants into the workforce were deficient. Employers claimed individuals with two-year or four-year degrees still lacked in communication skills (Conference Board, 2006). Further, as the economy is becoming more globalized, global teams in the workforce require individuals to be linguistically and culturally effective communicators (National Education Association, 2012). Researchers Walsh and Maloney (2007) explained the importance of global collaboration in the field of science and particularly the task of co-authoring scientific papers. A global, collaborative workforce supports Levy and Murnane's (2004) previously presented notion of the importance of complex communication skills in the future workforce.

Collaboration. The Partnership for 21st Century Learning (2015) defines collaboration as the ability to: (a) work together respectfully in diverse teams, (b) exercise willingness to be helpful and flexible in making changes to accomplish common goals, and (c) assume shared responsibility for work completed collaboratively, yet value individual contributions to the team. In an executive summary, the Organization for Economic Cooperation and Development (2005) illustrated teamwork and collaboration competencies as: (a) the ability to relate well to others, (b) the ability to cooperate, and (c) the ability to manage and resolve key conflicts.

Employers ranked collaboration as a key competency for success in the 21st century (Conference Board, 2006; OECD, 2005). As supported by many researchers, the ability to work with others is necessary due to a growing globalized world, the rise of technology, and flattened

corporations (Friedman, 2005; Jerald, 2009; National Education Association, 2012; Trilling & Fadel, 2009). As collaboration is exceedingly more global, students need to develop global literacy by understanding context and culture for people around the world (Bender-Slack, 2002; Bennett, 1993; Jerald, 2009). The National Education Association (2012) explained collaboration yields more holistic results since products are developed from multiple varying perspectives.

Creativity. Although creativity could be defined many ways, The Partnership for 21st Century Learning (2015) characterizes it into three categories, the ability to: (a) think creatively: use idea creation techniques, create new ideas, analyze and refine ideas to improve; (b) work creatively with others: implement and communicate ideas, be responsive and open to group input, understand real world limits on implementing ideas, view failure as learning opportunities; and (c) implement innovation: transform ideas into tangible and useful contributions. Creativity is highly linked to the other 21st century skills. For example the National Education Association (2012) suggested that in order to innovate, a student must be able to connect with others while communicating and collaborating.

Once viewed as a secondary skill, creativity and innovation are recognized as key drivers for the 21st century global economy (National Education Association, 2012; Partnership for 21st Century Learning, 2015). The National Center on Education and the Economy (2007) emphasized creativity as the differentiating skill to justify higher wages in the future. Divergent thinking and creativity can aid students faced with ill-structured problems (Levy & Murnane, 2004) as computers become more suitable to handle well-defined problems (Jerald, 2009). In his book outlining the five minds for the future, distinguished psychologist Gardner (2009) advocated for students to develop the creating mind to uncover and clarify new problems. Well-known author Pink (2006) further expressed, “In a world enriched by abundance but disrupted by

the automation and outsourcing of white-collar work, everyone must cultivate an artistic sensibility. We may not all be Dali or Degas. But today we must all be designers" (p. 69). Trilling and Fadel (2009) described it was a common misconception for creativity and innovation skills to be reserved for the artsy types. However, many researchers argue creativity can be nurtured in effective learning environments over time (Robinson, 2011; Trilling and Fadel 2009; Wegerif & Dawes, 2004). In their book, Wegerif and Dawes (2004) shared creativity can and be cultivated.

Leader in creativity and innovation, Sir Kenneth Robinson (2011), expressed how creativity did not only apply to what most recognized as special people. In his book, Robinson (2011) claimed the traditional rote memorization and testing as counterproductive to developing creativity. Unfortunately, the academic focus on high stakes testing has not allowed for an environment to foster creativity (Robinson, 2011; Silva, 2009; Wagner, 2014; Zhao, 2012). Testing in classrooms take place beginning in third grade until tenth grade. The results from these tests are used to measure both student learning and teacher effectiveness. Teachers may be worried about their own scores and do what is necessary to prepare students for the test (Zhao, 2012), which may not reflect real improvements on student learning (Collins & Halverson, 2009). Further, in an interview with Amy Azzam (2009), Robinson emphasized the value of creativity and collaboration combined:

> In practical terms, most creative processes benefit enormously from collaboration. The great scientific breakthroughs have almost always come through some form of fierce collaboration among people with common interests but with very different ways of thinking.
>
> This is one of the great skills we have to promote and teach—collaborating and benefiting from diversity rather than promoting homogeneity. We have a big problem at the moment—education is becoming so dominated by this culture of standardized testing, by a particular view of intelligence and a narrow curriculum and education system, that

> we're flattening and stifling some of the basic skills and processes that creative achievement depends on. (paras. 18-19)

Assessing 21st century skills. As the definition of 21st century skills continues to evolve, so do the strategies for measuring the skills. Assessing 21st century skills is different than what can be achieved in traditional content-based assessment formats (Razzouk & Shute, 2012; Salpeter, 2008). In an article comparing 21st century frameworks, Dede (2009) explained how research has documented higher-order thinking skills akin to sophisticated cognition as challenging to assess with the traditional constructed responses or multiple-choice tests.

Some efforts have been made to advance and develop new, more effective skills assessment tools. In an article about measuring 21st century skills, Silva (2009) discussed the emergence of models to measure both content and skills. Dede (2009) described research on virtual assessments for detecting higher-order thinking capabilities. His research, along with Ketelhut, Dede, Clarke, Nelson, and Bowman (2007) used virtual worlds to measure the processes of scientific thinking as a possible approach for more reliable, usable measures for 21st century skills. In an article, Salpeter (2008) identified project and portfolio assessments as a methodology for monitoring the progress of students' 21st century skills. Many researchers claim technology can help the advancement towards the next generation of skills assessment (Dede, 2009; Salpeter, 2008; Scheuermann & Björnsson, 2009).

Examples of assessment technologies for middle and high school students include College Work Readiness Assessment (CWRA; Dede, 2009; Silva, 2009) and the Key Stage ICT Literacy Assessment (Dede, 2009). Delivered over the Internet, the CWRA measures students' performance on constructed response tasks. Analytic written responses and performance tasks are also part of the CWRA. The Key Stage 3 ICT Literacy Assessment in Great Britain tests students' knowledge of Information and Communication Technology (ICT) skills while applying

complex problem solving. This assessment is conducted through a virtual world where students apply tools to sophisticated activities to solve problems and complete tasks (Bellanca & Brandt, 2010; Dede, 2009).

Most of the formalized skills-based assessments focus on middle and high school students. While literature is limited on these assessment tools for elementary students, some K-12 education trends are moving closer towards skills assessment. Although they are not new, performance tasks have more recently gained popularity in K-12 classrooms, and commonly used in elementary. Leading educator and researcher Grant Wiggins (1998) described performance tasks as learning activities that require students to perform or demonstrate knowledge and proficiency. Performance tasks present situations allowing students to apply learning in various contexts. Another K-12 trend is the development of rubrics to assess 21st century skills. One example includes the 4 Cs Rubrics created by EdLeader21 (n.d.), an organization partnering with the Partnership for Twenty-first Century Learning. These fee-based rubrics outline content from the Four Cs and are available for Grades 3-12.

Several challenges have hampered the development of the next generation of assessment tools. In their report on skills assessment, Scheuermann and Björnsson (2009) explained efforts to reshape skills assessments have been delayed due to barriers in technology and methodology. Silva (2009) faulted cost as a concern for restricted school district budgets. While traditional multiple-choice test costs about $1 per test (Government Accounting Office [GAO], 2003), the CWRA runs more than $40 per test (Silva, 2009). Challenges are also associated with the technical piece in developing new assessments. Researchers describe hands-on or virtual world assessments face technical, resource, and reliability challenges (Cronbach, Linn, Brennan, & Haertel, 1997; Shavelson, Ruiz-Primo, & Wiley, 1999). Although there are challenges, creating

open-ended, real-world contexts, with ill-structured problems is important for measuring performance (Lai, 2011). In the current education landscape, there does not seem to clear solution for assessing the development of students' 21st century skills in classrooms.

Instructional strategies for cultivating 21st century skills. Educationalists suggest different educational theories and instructional strategies for cultivating 21st century skills in the classroom. In terms of educational theory, researchers propose 21st century skills can be developed through a constructivist approach (Kent & McNergney, 1999; Noweski et al., 2012; Scheer et al., 2012). To support their study, Scheer et al. (2012) presented research from several German theorists supporting this view. In their book, Kent and McNergney (1999) drew a connection between web 2.0, technology, and constructivism. Theorized by Jean Piaget (1952), a constructivist approach consists of learners actively creating mental structures, described as schemas, from interaction with experiences in the world. New ideas and experiences are linked to past experiences, thus learners begin to construct their own meanings from these experiences (Piaget, 1952). Research on future skills often ties Dewey's work on experience to a constructivist approach in education (Scheer et al., 2012). Dewey (1913) advocated for students to engage in authentic, interdisciplinary projects; transforming school to be more like life itself. Research reveals interdisciplinary projects in real life contexts, instead of isolated subjects and disciplines, present advantages to student learning (Dewey, 1916; Scheer et al., 2012).

Although a constructivist approach may be desired, it is challenging to implement without an instructional framework for teachers to follow (Gardner, 2009; Scheer et al., 2012; Wagner, 2014). Literature suggests a few instructional frameworks with roots in constructivism for 21st century learning. The most notable instructional strategies involve student-centered methods, including problem or project-based learning (Pacific Policy Research Center, 2010;

Prince, 2004; Rotherham & Willingham, 2009; Sawyer, 2005; Snape & Fox-Turnbull, 2011; Thomas, 2000), and design-based learning (Barrows, 1985; Kolodner et al., 2003; Pacific Policy Research Center, 2010). Researcher Darling-Hammond et al. (2008) reviewed research on the described learning approaches*:* project learning, problem-based learning, and design-based learning. Trilling and Fadel (2009) presented a summary of Darling-Hammond et al.'s findings as follows:

> Students learn more deeply when they can apply classroom-gathered knowledge to real-world problems, and when they take part in projects that require sustained engagement and collaboration. Active and collaborative learning practiced have a more significant impact of student performance than any other variable, including student background and prior achievement. Students are most successful when they are taught how to learn as well as what to learn. (p. 108)

Project learning methods include completing complex tasks to create a product, event, or presentation (Trilling & Fadel, 2009). Often referred to as project-based learning, project learning dates back to Papert's (1980) theory of constructionism and Dewey's (1913) ideas about the advantages of learning by doing. Constructionism builds on the constructivist theory of learners actively constructing their own knowledge through experiences. However, learners construct a product as a representation of the learning in constructionism (Papert, 1980). This type of learning is situated in authentic, real word contexts.

In an article about project-based learning, Bell (2010) described it as an innovative approach where students learn through inquiry and work collaboratively to research and create an authentic product. Project-based learning is claimed to promote independent thinking, student motivation, collaborative skills, and self-regulation (Bell, 2010). Research reveals there are large benefits for students to work together. Darling-Hammond et al. (2008) found teams outperform individuals at any age in various problem types. Empirical studies such as Expeditionary Learning Outward Bound (1997) and Ross et al. (2001) both found students performed better on

tests during project learning than in traditional methods. Research also reveals project learning fosters more transferrable math concepts than standard textbooks (Boaler, 1999). In a study with students, Boaler (1999) found students engaging in project-based learning were able to recognize the application of learning.

Problem-based learning focuses on solving authentic, ill-structured problems in a case study context (Barrows, 1985, 2000; Ke, 2014; Savery, 2006). When explained in research, this approach is linked closely to medical education, business education, and law practice (National Research Council, 2000; Sawyer, 2005; Trilling & Fadel, 2009). Similar to project learning, problem-based learning shares roots in constructivism and situated learning. Problems are proposed in a real-life context, thus students resort to domain knowledge aiding in knowledge transfer to future situations (Hung, 2002; Ke, 2014). Learners work in teams engaging in collaborative inquiry, which results in a social construction of knowledge (Sawyer, 2005). The National Research Council (2000) described problem-based learning develops flexible problem solving, communication, and knowledge application to real world situations.

The third effective instructional strategy discussed is design-based learning. In addition to the shared constructivist and situated learning approaches of the previously described strategies, design-based learning borrows ideas from both project-based and problem-based learning. In design-based learning, students problem solve by applying a formal design process to create an artifact (Ke, 2014). Learning is situated in a problem (Cassim, 2013), similar to problem-based learning, yet takes on a constructionist perspective (Kafai, 1996) by collaboratively designing an artifact.

Research presents two design processes most common for implementing design-based learning in the classroom: Learning by Design™ (Kolodner et al., 2003), and design thinking

(Brown, 2008). The concept of approaching pedagogy from a design perspective is less studied than project-based or problem-based learning, as the idea is a more recent development in research. Learning by Design™ is recognized as a project-based approach to science learning (Kolodner et al., 2003). Supporting resources for Learning by Design™ can be found in books (Kalantzis & Cope, 2005) or on the Internet. However, as a newer discipline, there is a lack of research in design thinking as an instructional strategy. Prior research on design-based learning recommends for future research to focus on the impact of design thinking in classrooms (Ke, 2014). The next section in this chapter presents research on design thinking and its application to the classroom.

Foundations of Design Thinking

Although the concept of design has existed for a long time, design as a discipline did not emerge until the last few decades. Brown (2008) and Wetzler (2013) both claimed design thinking did not gain popularity until the last 15 years. Moreover, design thinking transpired as a result from ideas of several influencers in the design discipline. To understand the underpinnings of design thinking, it is crucial to discuss a brief history of the ideas and individuals that have influenced the shaping of this concept.

Traces of the design thinking mindset began around the formation of the design science field in the 1960s. One of the earliest contributors to the thought process founding design thinking is Nobel Laureate and American economist Herbert Simon (Buchanan, 1992; Dunne & Martin, 2006; Kimbell, 2011). In Simon's (1969) book, *Sciences of the Artificial*, Simon presented a three-phase model on decision-making that reflects the basis of several design thinking frameworks. This model consists of: (a) intelligence: examining the problem and gathering data, (b) design: building different solutions to the problem, and (c) choice: comparing

the best solutions from Design against each other. Upon completing the choice phase, the preferential design would be selected and iterated on for improvement (Simon, 1969). The ability to iterate and improve upon the design in effort to work towards a preferential outcome is what Simon (1969) called the artificial world, and is crucial to Simon's model. Thus, he became an early proponent of rapid prototyping, an important concept in design thinking.

Another contributor to the formation of design thinking is Victor Papanek (1972), who shared an anthropology perspective for the design world through his book, *Design for the Real World.* Papanek's work introduced the need for design to be socially and economically responsible. These principles were applied to large-scale projects with UNESCO and the World Health Organization (Papanek, 1972). This work opened the door to using design concepts outside of the design industry to help solve real problems in the world.

Fundamental to the foundations of design thinking are design theorists, Horst Rittel and Melvin Webber. In 1973, Rittel and Webber coined the term wicked problem, which has become a common term used in the design field. Wicked problems are described as problems that do not have an absolute solution, thus require creativity and abductive reasoning to determine potential solutions (Rittel & Webber, 1973). Rittel and Webber's work on defining design problems is crucial in the development of design thinking; their work is often cited when presenting the complexity to understand the nature of the design process.

The next phase of work contributing to design thinking occurred in the 1980s from researchers Nigel Cross and Donald Schön. These researchers investigated the processes and mindsets of designers in effort to determine how designers cultivated creative ideas. Cross's (1982) book, *Designerly Ways of Knowing,* argued designers approach problems differently than non-designers. In particular, designers have a specific process and way of thinking in order to

reach solutions. Schön's work challenges ideas from the 1960s when design was considered a problem solving activity. In contrast, Schön argued instead of focusing on the given problems, designers should focus on the process for the decision to be made, the problem setting. (Schön, 1983). Schön's (1983) seminal book, *The Reflective Practitioner*, also stressed the importance to focus on self-reflection within the design process. This work is especially critical to the application of design thinking in education.

The service design industry emerged in the 1990s when the scope of design opened its doors to service-oriented design tools. At the forefront of this shift was Richard Buchanan, who re-surfaced the ideas of Rittel and Webber's work on wicked problems. Buchanan (1992) described design thinking as the tool for solving Rittel and Webber's notion of wicked problems. Buchanan (1992) made two additional points in his paper towards developing the idea of design thinking. First, design thinking can be applied to any discipline, not just the arts and sciences (Buchanan, 1992). Next, he introduced the notion that design thinking can be useful in organizations as a tool to solve complex systems and broader questions (Buchanan, 1992).

Contemporary design thinking. Each individual discussed in the previous section played a part in shaping the mindset and process behind design thinking. From these influencers, several individuals and organizations have emerged to pave the way for design thinking. This section discusses modern influencers in design thinking, proposes a definition, and presents a process for a design thinking framework.

In 1991, David Kelley founded the international design and consulting firm, IDEO, in Palo Alto, California. IDEO is currently a leader in design thinking and helped popularize the concept by bringing together thought leaders, conducting research, publishing books, and founding a design school, known as d.School. Leading the way at IDEO is CEO, Tim Brown,

whose work is crucial to the contemporary emergence of design thinking. Brown's (2008) article "Design Thinking" published in the Harvard Business Review, is probably the earliest and most often cited articles on design thinking. In this article and his book, *Change by Design*, Brown (2009) shared experiences from IDEO and explained the organization's approach to implementing design thinking in businesses, activities, and services. Brown (2009) presented a combination of ideas from design antecedents by highlighting the following as aspects of design thinking: (a) collaboration, (b) empathy, (c) optimism, and (d) experimentalism.

In 2008, Brown shared David Kelly established the term *Design Thinking* in 2001 as it is commonly referred to in modern day. In addition to founding IDEO, Kelly also founded Stanford University's Hasso Plattner Institute of Design (d.School). Stanford's Institute for Design has published various materials to support the design thinking practice suitable for any industry. An example of these resources is the Bootcamp Bootleg (Hasso Plattner Institute of Design, 2010) which is an evolving toolkit outlining the mindset, as well as the "how" and the "why" for practicing design thinking. These resources, along with the research courses, events and design community networking, have helped popularize design thinking. In an effort to spread the value of design thinking, Kelley founded a d.School in Germany and several other countries around the world.

In terms of disciplines, design thinking is considered to be part of the engineering design sciences (Owen, 2007; Simon, 1969). However, the process is growing popularity and is applied to a wide range of contexts such as healthcare (Bate & Robert, 2007; Johnson et al., 2016; McCreary, 2010), education (Dym, Agogino, Eris, Frey, & Leifer, 2005; Fricke, 1999; Nagai & Noguchi, 2003) and business (Brown, 2008; Dunne & Martin, 2006; Ignatius, 2015; Martin, 2009). In their book, Bate and Robert (2007) described employing design strategies as the key to

uncovering how healthcare patient services could be improved. McCreary (2010) reported results from a project with Kaiser Permanente and IDEO whom incorporated design thinking strategies to improve patient care. Johnson et al. (2016) described design thinking as an innovative methodology in their study about reducing heart failure readmissions. In an article with PepsiCo's CEO Indra Nooyi, she described design thinking as the driving innovation that changed her company to thrive (Ignatius, 2015).

Roger Martin is a thought leader in promoting design thinking outside of the design discipline. In an interview with David Dunne, Martin expressed business education should be more like design education (Dunne & Martin, 2006). Martin's (2009) book, *The Design of Business*, advocated for design thinking in business settings. Martin (2009) built on the idea that design thinking is useful for addressing wicked problems (Buchanan, 1992; Rittel & Webber, 1973) in business related to management, systems design, and marketing. In particular, he proposed three areas from design thinking that is helpful to business management: (a) cognitive: designers need to practice abductive thinking to generate, follow, and test ideas; (b) attitudinal: constraints are embraced rather than seen as barriers; and (c) interpersonal: empathy is employed to understand the user and also during collaboration in the design process.

As other industries have recognized the value of design thinking, teaching the approach has become more popular in university programs. Design thinking is widely taught in engineering, architecture, and design majors at universities. (Dym et al., 2005; Fricke, 1999; Nagai & Noguchi, 2003). In an empirical study, Dym et al. (2005) described engineering design thinking curricula as a way to teach divergent-convergent thinking and systematic questioning. In an experimental study with university Design students, Nagai and Noguchi (2003) suggested following a thinking process was a way to shed light on the creative thinking process. In an

article, Fricke (1999) recognized the value of the design process in education since it was as a way to change how people learn and solve problems. Some universities offer dual degrees paired with design, such as the Illinois Institute of Technology's MBA and Masters in Design program (Wrigley & Straker, 2017). Goldman et al. (2014) presented in their study that a quick search revealed over sixty universities offering some sort of design thinking training in the form of workshops, courses, degrees, or supplemental programs. In their study on design thinking pedagogy, Wrigley and Straker (2017) emphasized integrating design thinking into university coursework could foster the highly sought after multidisciplinary skills necessary for real world projects.

Defining contemporary design thinking. It is challenging to apply a definition to design thinking. In a research paper, Dorst (2011) explained defining design thinking risks oversimplifying the rich perspectives on the subject. Recently, an expert called design thinking a bundle of mindset and philosophies all wrapped in one term (Lahey, 2017). In their research paper, Braha and Reich (2003) characterized the process as iterative, exploratory and often chaotic. Design thinking is frequently employed to describe: what designers do, what designers know, and how designers approach design (Kimbell, 2011). Thus, it is not just a process but also a mindset.

Although there are many versions and interpretations of design thinking, Waloszek (2012) concluded they all share the same sentiments: (a) understanding the problem; (b) observing others; (c) interpreting the results; (d) generating ideas; (e) building prototypes; and (f) testing, implementing, and improving. Brown (2008) provided a functional definition in his book, calling design thinking "…a human-centered, creative, iterative, and practical approach to

finding the best ideas and ultimate solutions. Design thinking is just such an approach to innovation" (p. 92).

In order to aid implementation on a grander scale, organizations have focused on defining the steps in which designers create, gather feedback, and iterate (Razzouk & Shute, 2012). As a leader in the industry, The Hasso Plattner Institute of Design (2010) defines the iterative, often nonlinear steps (see Figure 2) as follows:

1. Empathize with the user or target audience through observation, engagement, and watching and listening.
2. Define a meaningful and actionable problem statement.
3. Ideate by combining the understanding of the problem and needs of the target audience; present a wide possible range of ideas, not the single, best solution.
4. Prototype by building artifacts to get closer to the final solution.
5. Test the prototypes, gather feedback, and revisit steps in order to get closer to the solution.

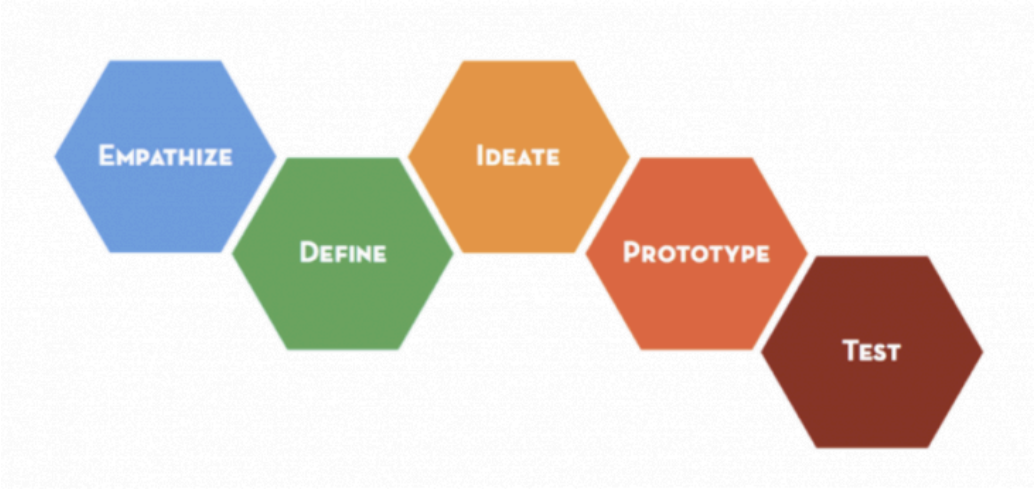


Figure 2. Design thinking steps. From "Design Thinking Process" by Hasso Plattner Institute of Design at Stanford University. Copyright [n.d.]. Reprinted with permission.

The Hasso Plattner Institute of Design (2017) described each step for users in *An Introduction to Design Thinking Process Guide*. In the first stage, Empathize, designers work to understand the people and context of the design challenge. This human-centered approach helps designers understand the physical and emotional needs of the people impacted by the design challenge, including what is meaningful to them (Brown, 2008; Carroll et al., 2010; Kwek, 2011; Hasso Plattner Institute of Design, 2017; Rice, 2011). In a middle school study, Kwek (2011) expressed practicing design thinking involved empathy and understanding the needs of others. To help build empathy, designers observe users and behaviors in context as much as possible. Designers engage with users in conversation to elicit stories and uncover deeper meanings. Additionally, they watch and listen by asking users to walk them through steps of tasks typically performed or anything that could prompt deeper questions in order to gain empathy (Hasso Plattner Institute of Design, 2017).

The second stage, Define, is "about bringing clarity and focus to the design space " (Hasso Plattner Institute of Design, 2017, p. 3). Designers apply what was learned in the previous stage to define the challenge more clearly. In their studies, Noweski et al. (2012) and Scheer et al. (2012) described the design challenge as an actionable problem statement focusing on insights from the user and context. In design thinking, this activity is referred to as gaining a point of view (Brown, 2008; Carroll et al., 2010; Goldman & Kabayadondo, 2016; Goldman et al., 2014; Hasso Plattner Institute of Design, 2017). In their study about design thinking in middle school, Carroll et al. (2010) described a Point of View statement as determining the users' needs and insights. During this stage, designers consider patterns, behaviors, or feelings that may have stood out in the first stage. Designers synthesize this information to gain an

understanding of whom they are designing for as well as their needs (Hasso Plattner Institute of Design, 2017).

The third stage, Ideate, is where designers generate a range of possible ideas as innovative solutions for the design challenge (Brown, 2008; Carroll et al., 2010; Goldman & Kabayadondo, 2016; Hasso Plattner Institute of Design, 2017; Scheer et al., 2012). During this stage, designers brainstorm with their design teams to build ideas. Designers are encouraged to work collaboratively and exercise creativity. Goldman and Kabayadondo (2016) expressed the importance that no idea is too far-fetched; it is about fun and creativity. This stage is about going wide instead of determining the right answer (Rice, 2011; Scheer et al., 2012). Finding the best solution comes later through testing and feedback (Hasso Plattner Institute of Design, 2010).

In the fourth stage, Prototype, designers build a low-resolution prototype to elicit feedback from the user affected in this design challenge (Brown, 2008; Carroll et al., 2010; Hasso Plattner Institute of Design, 2010; Scheer et al., 2012). Prototypes could be as simple as a post-it note or storyboard, or it may be a representation of a gadget (Hasso Plattner Institute of Design, 2010; Rice, 2011). Designers are encouraged to start building without becoming too attached to any one prototype. Carrol et al. (2010) explained it is best to "fail early and often" (p. 41) during the prototype phase. The goal is to develop a mental concept of the idea, or ideas, by collaborating with design teams (Scheer et al., 2012).

The fifth stage, Test, consists of designers eliciting feedback about the prototypes from users (Brown, 2008; Carroll et al., 2010; Hasso Plattner Institute of Design, 2017; Scheer et al., 2012). Testing allows designers to refine prototypes and solutions, learn more about the users, and refine a point of view for the design challenge (Hasso Plattner Institute of Design, 2017). During testing, designers share the prototype with the user and watch how they interact with it. It

is the goal of the designer to make testing feel like an experience rather than explaining the prototype (Hasso Plattner Institute of Design, 2017). In their study, Scheer et al. (2012) explained Test as the last linear stage in the process, but iterating on the design is technically the sixth step. In an analysis, Stempfle and Badke-Schaube (2002) revealed working in an iterative nature helps narrow down the problem to develop an optimal solution.

The Hasso Plattner Institute of Design (2010) emphasized although the process is presented in a linear fashion, it is not uncommon to work through stages in various orders. Designers may cycle through the process multiple times to keep refining a solution (Hasso Plattner Institute of Design, 2010). In a study, Goldschmidt and Weil (1998) found designers working in this process practice forward and backward reasoning strategies. In an article on the Making movement, Bowler (2014) claimed the open-ended nonlinear nature of design thinking fosters the thinking necessary for innovative and creative solutions.

In addition to the described steps involved in the design thinking process, it is important to mention the cognitive skills practiced regarding mindset. Carroll et al. (2010) described the following guidelines for the design thinker mindset: empathy, human-centeredness, mindfulness of process, radical collaboration, show don't tell, and a culture of prototyping. An important cognitive skill applied while moving through the design thinking process is reflection.

In a book about the design process, Lawson (2006) built on Schön's (1983) concept of the reflective practitioner by explaining design thinkers practice reflection in action and on action. An ethnographic study in a high school engineering course reported the iterative nature of the design process strengthened reflective thinking (Sabag, Trotskovsky, & Waks, 2014). In an article, Cassim (2013) expressed by practicing reflection designers could focus on the process rather than the end result. Design thinking also exercises critical skills such as empathy,

exploration, collaboration, reflection, and risk-taking (Carroll et al., 2010; Cross, 1982; Michlewski, 2008). In a chapter on design thinking, Koh, Chai, Wong, and Hong (2015) claimed metacognition was strengthened through the process of exploring and reframing wicked problems to create solutions.

Design thinking in K-12 education. Research suggests implementing the process of design thinking in education is impactful (Noweski et al., 2012; Rauth, Köppen, Jobst, & Meinel, 2010; Razzouk & Shute, 2012). In a study with students in higher education, Rauth et al. (2010) presented the design thinking process as a tool for solving everyday problems. Their research found design thinking could foster creative thinking, recognized as creative confidence, in students. Razzouk and Shute (2012) in a research discussion expressed helping students learn to think like designers could prepare them for challenging situations in school, careers, and throughout life.

Researchers also suggest the skills acquired from the design thinking process can assist students in subject areas while building cognitive and social skills (Goldman et al., 2014; Kafai & Resnick, 2000; Kolodner et al., 2003; Todd, 1999). In his report, Todd (1999) defined this as an integration of learning. He explained it as a similar concept to across the curriculum, but useful for subjects such as science and technology. Design thinking, as an instructional strategy, practices several educational theories such as a constructivism (Piaget, 1952), social learning (Vygotsky, 1978), constructionism (Papert, 1980), and Dewey's (1916) ideas on real-life experiences.

An important area to highlight is current research connecting the design thinking process to constructivism. Scheer et al. (2012) proposed when used as a teaching methodology, the process of design thinking helps bring constructivist theory to reality. As a well-known and

valued concept, constructivism allows learners to experience an active process of making their own individual meanings through knowledge construction. Since constructivism can be difficult to implement in a classroom without a process, Noweski et al. (2012) and Scheer et al. (2012) argued design thinking as an ideal strategy for applying this theory to practice. Scheer et al. (2012) explained, "Design Thinking is a constructivist learning design, because of its qualities in training certain skills, which are predispositions for a constructive way of learning: motivation for exploration, openness for new ideas, creative thinking and other metacognitive" (p. 11).

Another area to highlight is the social and collaborative component of design thinking through working in design teams. The social aspect of design thinking supports Vygotsky's (1978) seminal work on social learning. Vygotsky argued offering opportunities to collaborate with other individuals socially is an essential component to cognitive development and learning. Further supporting this view, Bakhtin (2010) argued in his book language is practiced as individuals engage with each other. As human-centeredness and deep collaboration is the foundation for design thinking, current research suggests the process lends well to social processes of learning (Goldman et al., 2014). The team interactions in design thinking supports a social skills and development in learners (Caroll et al., 2010; Goldman et al., 2014; Johansson-Sköldberg, Woodilla, & Çetinkaya 2013; Scheer et al., 2012; Vogel, 2009).

Extending on constructivist ideas, design thinking is also embedded in constructionism as students develop an artifact as a representation of knowledge. In a book, Kafai and Resnick (2000) indicated a close relationship between design and learning theories, specifically constructionism. Design theorists and learning theorists both value the "construction of knowledge" as an essential component to the learning process (Kafai & Resnick, 2000). In his paper, Oxman (1999) described design thinking as the process of knowledge acquisition and

creation of the physical representation of that knowledge. In the spirit of constructionism, it is also suggested design challenges offer opportunities for learners to share personally meaningful objects with an audience (Harel & Papert, 1990; Kafai, 1996), which furthers the ability to investigate, interpret data, and apply changes (Kolodner et al., 2003).

Design thinking also supports many of Dewey's (1916) ideas on the changing world by participating in active problem solving (Goldman et al., 2014; Scheer et al., 2012). In conjunction with constructivism, Dewey indicated a problem solving method should be centered on inquiry in a real life context motivating learners to analyze and explore. Scheer et al. (2012) suggested design thinking as the methodology to support the abstractness and density of Dewey's ideas. "Design thinking can give concrete recommendations for distributing a complex phenomenon without abstracting too much, but still being digestible for the student and implementable for the teacher" (Scheer et al., 2012, p. 11).

Design thinking and 21st century skills. Labeled as "a powerful methodology for innovation" (Leifer & Steinert, 2011, p. 151), studies claim design thinking can mediate 21st century learning (Noweski et al., 2012; Scheer et al., 2012; Todd, 1999). Noweski et al. (2012) claimed design thinking develops a mindset that is required for success in the 21st century. Todd (1999) expressed participating in design thinking activities prepare students for fundamental skills for life in the 21st century. Scheer et al. (2012) reported design thinking as a tool for problem solving and facilitating interdisciplinary projects. In their book about design and learning, Davis, Hawley, McMullan, and Spilka (1997) presented design thinking as inherently interdisciplinary, allowing teachers to naturally draw connections between disciplines rather than feeling forced and inauthentic. Research also highlights positive benefits from interdisciplinary

projects. In a seventh grade interdisciplinary design challenge, Schooler (2004) reported teachers claimed their students improved in higher-order thinking skills such as syntheses and evaluation.

Literature asserts design thinking fosters innovation as it requires "out of the box thinking" to come to a creative solution (Barlex & Trebell, 2008; Darling-Hammond et al., 2008; Gerber & Carroll, 2012; Luka, 2014; Rice, 2011). In an article, Luka (2014) expressed in design thinking pedagogy students must apply creativity, critical thinking, and communication collaboratively in order to solve problems in real life context. In an ethnographic study at a high-tech firm, Gerber and Carroll (2012) concluded creativity was strengthened through the process of rapid prototyping. In a ninth grade design challenge, Barlex and Trebell (2008) reported imaginative thought and creativity were strengthened. As a summary of her research, Darling-Hammond et al. (2008) argued a design challenge as one of the most effective ways to develop creative skills in preparation for the Age of Innovation.

Studies suggest design thinking fosters the development of collaborative skills (Kangas et al., 2013; Kolodner et al., 2003). In an elementary study employing design thinking, Kangas et al. (2013) revealed the nature of design as implicitly collaborative. Kolodner et al. (2003) expressed designing affords collaborative skills as designers must present and discuss ideas with other. Design thinking also directly supports Levy and Murnane's (2007) ideas on future workplace problems. In participating in a design challenge, students have the opportunity to work through ill-structured (Rittel & Webber, 1973) authentic challenges. Experiencing authentic problem solving or ill-structured problems strengthens communication, metacognition, and self-reflection skills (Conlin, Chin, Blair, Cutumisu, & Schwartz, 2015; Cross, 1982; Kolodner et al., 2003; Sabag et al., 2014).

Koh et al. (2015) presented a direct connection between design thinking and 21st century learning. In their book, they claimed design thinking in classrooms can foster the defined five dimensions of 21st century learning: (a) socio-cultural: demanding collaborative and cross-cultural skills, (b) cognitive: demanding critical and creative thinking skills, (c) metacognitive: demanding self-assessment and reflection, (d) productivity: demanding authentic tasks and development of products, and (e) technological: demanding technology proficiency. Many of the dimensions in this research reflect the standards presented by the Partnership for 21st Century Learning' Framework for 21st Century Learning.

In their research on instructional strategies, Darling-Hammond et al. (2008) reported strategies founded on design principles had the greatest impact in math and science. As presented, the majority of design thinking research in K-12 is focused around STEAM initiatives in middle school and high school classrooms. Rice (2011) suggested for design thinking to be embraced to aid high school reform. In a study of high school students in an engineering course, Berland et al. (2013) reported the improvement of application of science concepts to engineering tasks. In a study focusing on high school students designing games, Casey et al. (2011) reported how design thinking facilitated a sophisticated understanding of game structure. Jarrett (2016) described design thinking as the foundation to his middle school Makerspace initiative in support of STEAM. Design thinking is commonly practiced as part of the curriculum in school Makerspaces (Jarrett, 2016). Although there are resources to support design thinking across K-12, there is minimal research in elementary classrooms in varying disciplines.

Examples of design thinking resources in K - 12 classrooms. Majority of the resources supporting design thinking in a K-12 context consists of frameworks, guides, and books. The most notable resources derive from design thinking influencers, such as IDEO or programs at

Stanford University. The K-12 Lab Network and REDlab (Research in Education and Design) are two fellow organizations stemming from Stanford University. The K12 Lab is a network of individuals contributing to the goal of helping bring design thinking to schools. The lab acts as a support system for educators to network, learn more about design thinking through published research, and gather ideas from shared curriculum experiences (Hasso Plattner Institute of Design, 2017). As part of Stanford's K-12 education initiative, REDlab conducts research on design thinking in K-12 context. REDlab continues to publish various studies informing educators about the value of design thinking in education.

In 2012, IDEO published *Design Thinking for Educators*, a resource for K-12 educators. The guide provides an explanation of the design thinking process and steps for getting started. IDEO's (2012) adapted design thinking process for educators is presented as:

- Discovery: "I have a challenge. How do I approach it?" (p.16). This phase focuses on understanding the challenge, preparing research, and gathering inspiration.
- Interpretation: "I learned something. How do I interpret it?" (p.16). This phase focuses on telling stories, searching for meaning, and framing opportunities.
- Ideation: "I see an opportunity. What do I create?" (p.16). This phase focuses generating and refining ideas.
- Experimentation: "I have an idea. How do I build it?" (p.16). This phase focuses on making prototypes and getting feedback.
- Evolution: "I tried something new. How do I evolve it?" (p.16). This phase focuses on tracking learning and moving forward.

The guide explains the aspects of defining a challenge, preparing a project plan, and implementing a design challenge. Worksheets and implementation suggestions are also

presented. Although the guide could be applied in any educational context, the examples are framed around educators working on design challenges together rather than working with students in classrooms.

Another K-12 adapted design thinking process was published in the past few years. In 2016, two educators, Spencer and Juliani published *Launch: Using Design Thinking to Boost Creativity and Bring Out the Maker in Every Student* as a guide for implementing design thinking in K-12 classrooms with students. The LAUNCH Cycle transfers the concept of design thinking into actionable steps fitting for teachers and students. The LAUNCH Cycle (Spencer & Juliani, 2016) consists of the following phases:

- Look, Listen, and Learn - This phase focuses on the student generating awareness to discover more about the challenge (p. 55).
- Ask Lots of Questions - This phase focuses on students creating questions individually or collaboratively in order to understand the problem. "Sentence stems" (p. 56) are encouraged for students who need help articulating curiosity.
- Understand the Process or Problem - This phase focuses on students researching through interviews or texts to understand the problem. Structure provided by the teacher varies on class needs (p. 56).
- Navigate Ideas - This phase focuses on brainstorming a range of ideas for the problem. Students develop a concept for what they will create (p. 57).
- Create a Prototype - This phase focuses on students building a model of their concept (p. 57).

- Highlight and Fix - This phase focuses on students testing what works or what does not work, then making changes to the prototype. Students revise until the product is ready to launch (p. 58).
- Launch - This phase focuses on students "launching" their design to an audience. Students explain their design and try to determine if their idea is working (p. 58).

Once students are ready, the product is presented in Launch with an authentic audience and feedback is gathered (Spencer & Juliani, 2016). The book also consists of worksheets and ideas for implementing the cycle in the classroom. In addition to the book, the authors offer LAUNCH projects and classes to educators for a fee.

Summary

Informed by economic research on future trends (Jerald, 2009; Trilling & Fadel, 2009), the 21st century learning movement calls for a focus on future skills such as critical thinking, communication, collaboration, and creativity (Partnership for 21st Century Learning, 2015). Research shows taking a constructivist approach to learning in K-12 classrooms can develop these skills. However, instructional strategies are necessary for aiding implementation (Noweski et al., 2012; Scheer et al., 2012). Instructional strategies suggested for fostering effective learning in the 21st century include project-based learning, problem-based learning, and design-based learning (Barrows, 1985; Kolodner et al., 2003; Pacific Policy Research Center, 2010; Prince, 2004; Rotherham & Willingham, 2009; Sawyer, 2005; Snape & Fox-Turnbull, 2011; Thomas, 2000). As the design world has emerged over the past few decades (Brown, 2008), there is a need to study the impact of design-based learning strategies, particularly design thinking, in a K-12 context.

Current literature shows design thinking can help develop a mindset and the skills in demand of the 21st century (Noweski et al., 2012; Scheer et al., 2012; Todd, 1999). However, most of the research draws connections between design thinking and STEM in middle school or high school classrooms (Berland et al., 2013; Bowler, 2014; Casey et al., 2011; Jarrett, 2016; Rice, 2011). This study explores integrating design thinking into existing academic content with students in an elementary classroom. It is the hope of the researcher that this study adds to literature on design thinking in an elementary school context in any discipline; pecifically, by providing an example of a design thinking implementation for educators to reference as a resource.

Chapter Three: Methods

This study explored the implications of implementing a design thinking process as an instructional methodology in an elementary school classroom. This chapter describes the case study methodology by which this intervention was examined. After the research design and case are explained, sources of data and data collection strategies, human subject considerations, validity, data analysis procedures, and the presentation of findings are discussed.

Study Purpose and Research Questions

The purpose of this exploratory case study was to describe the process and outcomes of implementing a design thinking process into learning activities within an existing curriculum for students in elementary school classrooms. One teacher participant partnered with the researcher to implement the design thinking process in his third grade classroom. The results of this study explore how integrating the design thinking process as a pedagogical framework into existing curriculum offered a way to cultivate students' 21st century skill development. To provide a workable definition, 21st century skills were recognized as the Four Cs: critical thinking, communication, collaboration, and creativity (Partnership for 21st Century Learning, 2015). Results also explore practical strategies for implementing design thinking in classrooms.

The central research question that guided this study was:

- How does implementing the design thinking process into learning activities with elementary school-aged children foster the development of critical thinking, communication, collaboration, and creativity?

The sub-questions were:

- Questions Related to Student Participants

1. What does it look like for students to engage in design thinking learning activities in the classroom?
2. How do students perceive design thinking learning activities?
3. Do students demonstrate critical thinking, communication, collaboration, and creativity skills while participating in design thinking learning activities? If so, how?

- Questions Related to the Teacher Participant
  1. How does the involved educator believe the use of design thinking contributes to the acquisition of critical thinking, communication, collaboration, and creativity in an elementary school classroom?
  2. What challenges are anticipated by the educator for implementing design thinking within instructional plans?

Research Design

Case study research focuses on "the study of an issue explored through one or more cases within a bound system (i.e., a setting, a context)" (Creswell, 2007, p. 73). Case study research is common in the social sciences (Creswell, 2007; Stake, 1995; Yin, 2018), and became more prominent in education ten years ago (Gulsecen & Kubat, 2006), as an empirical method for investigating a phenomenon within a real world context (Yin, 2018). As a qualitative approach, case study research explores a case over time using multiple sources of information to collect detailed, in-depth data (Creswell, 2007). The multiple sources of data are analyzed to present a holistic view on the issue being studied (Yin, 2018). Although the design is qualitative in nature, both quantitative and qualitative data are collected to describe the process and outcome of the phenomenon (Tellis, 1997).

A case study methodology was selected for this study since it allowed the researcher to examine data within a specific real-world context (Zainal, 2007). The study was exploratory in nature as the researcher sought to explore the phenomenon in data (Zainal, 2007) using a variety of what types of questions (Yin, 2018). Additionally, this study was considered an instrumental case study as the goal sought to provide insight into the issue, allowing for generalizations. Although context and activities are examined in depth, the purpose of an instrumental case study is to support the understanding of something else (Stake, 2008).

It is important to clarify the researcher's theoretical disposition that guides a study (Yin, 2018). This case study took a naturalistic approach as the qualitative data from the design thinking intervention sought to explore students' perspectives and experiences. At the heart of classrooms is human nature consisting of various backgrounds and perspectives of teachers and students. A naturalistic approach helps the researcher examine how the teacher and students experienced events in the classroom and the meanings attached to them (Stake, 1995; Stringer, 2008). This is similar to a phenomenological approach, which places the researcher in touch with people's everyday experiences (Van Manen, 1984).

The phenomenological perspective applied to naturalistic inquiry provides the researcher with tools to understand how educational activities can be meaningful and impact lives (Stringer, 2008). According to Yin (2018), it is important to consider theoretical propositions at the beginning of a study. This study was designed with the theoretical proposition that design thinking fosters the development of the Four Cs. By considering the theoretical proposition during research design, a stronger foundation for data collection and analysis was established (Yin, 2018).

The researcher incorporated reflective practices during the study. In addition to identifying the researcher's personal background, the researcher wrote reflective notes (recorded in field notes) during this study. The reflective notes served a few purposes. First, prior to data collection, the researcher identified and recorded her assumptions (bracketing) in the notes. Also in the notes, the researcher recorded self-reflective information throughout the study. Last, the researcher revisited previously indicated assumptions written in the notes during data analysis.

The Case

The case involved students and a teacher from one elementary school classroom located in San Francisco Bay Area, California. The primary source of data came from the students participating in the design thinking challenge during the Fall of 2018. The participants consisted of 25 third grade students and their teacher. The teacher engaged in the development and implementation of the lessons involved in the study, so his perspective and interaction with students also provided relevant and important data. One class was chosen to participate in this study due to the unique amount of collaboration and time required by the teacher. The duration of the study, from pre-study preparation with the teacher to the last lesson implementation, occurred over a three-month period.

Preparation for implementation. Before the study commenced, the researcher met twice with the participating teacher in September of 2018 at the school site (see Figure 3). The purpose of the first meeting was to introduce the study and participant requirements, namely classroom time involvement. The study's information sheet and confidentiality requirements were also confirmed during this meeting. The second meeting focused on familiarizing the teacher with design thinking, discussing an implementation timeline, and collectively determining the best place to integrate a design thinking challenge into the existing curriculum.

A class roster detailing students' names, ages, and genders was also collected at this time. Meeting agendas (see Appendix A) were applied to strengthen reliability of this study.

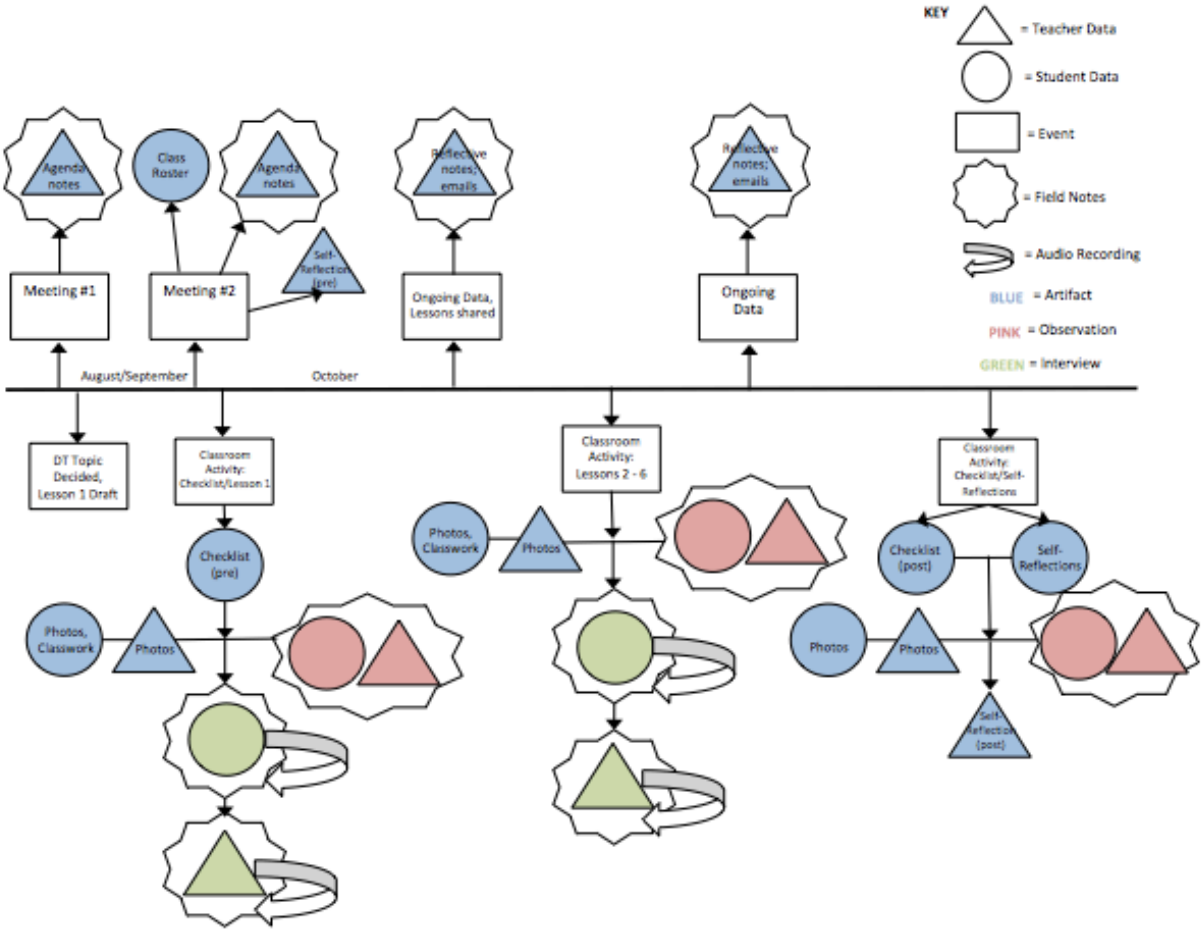


Figure 3. Research implementation schedule, including timeline and data collection.

The teacher and researcher decided on the cadence of conducting one design thinking lesson per week, beginning in October of 2018. They agreed to schedule about an hour and a half for each week, permitting time for the lesson and coordinating interviews. To ensure familiarity for students, it was agreed the teacher would be responsible for facilitating the lessons in his classroom. However, the researcher was responsible for developing the lessons and sharing them with the teacher for feedback before each scheduled lesson. Additionally, the teacher and researcher decided to focus on the interaction between Native Americans and new settlers as the

curricular topic for the challenge. This topic is part of the third grade social studies curriculum for students in California.

Upon mutually deciding on the topic within the existing curriculum, the researcher brainstormed ideas and reviewed existing ideas for the design thinking challenge. While browsing relevant websites, the researcher discovered a potential idea for the design thinking challenge on the d.loft STEM Learning website. D.loft STEM Learning (n.d.) is part of Stanford's REDlab, and describes their organization as, "An education and research project that combines STEM with design thinking practices and mindsets to empower educators and introduce students to new learning and career opportunities" (para. 2). The d.loft webpage contained several examples of educator-designed curriculum. One example in particular, titled *Designing a Co-Habitable Space for Native Americans and Missionaries* (Ward & Yamada, n.d.), piqued the interest of the researcher. Although the content was aligned to fourth grade standards, the researcher recognized how this could be adapted for students in third grade and coordinate with the chosen topic. As a result, the researcher e-mailed a member of the d.loft team to discuss permissions for the study. Within 24 hours, she responded granting permission to use or modify any of the resources found on the website. She further explained the goal of sharing the resources on the website was to distribute them as widely as possible (see Appendix B, e-mail).

The researcher proposed the idea of the design thinking challenge to the teacher via e-mail. After several e-mail exchanges, they agreed it would work well for the classroom and for the study. Not only did the challenge align to CA History Standards, but also Common Core State Standards (CCSS), Next Generation Science Standards (NGSS), and International Society for Technology in Education (ISTE) Standards for Students. With a mutual understanding of the

overarching goal for the challenge, the teacher and researcher decided to approach the lessons week-by-week. Therefore, the researcher shared each upcoming lesson via e-mail one week prior to implementation. The researcher was responsible for completing the entirety of each lesson, such as identifying the relevant standards and materials, and developing activities for each lesson. The researcher was also careful to include activities to foster the design thinking mindset (Carroll et al., 2012). Each week, the teacher reviewed the lesson and replied with questions or modifications over phone or e-mail until both parties agreed on the lesson activities.

Due to its applicability in elementary school, this study adopted a school-adapted design thinking process created by Spencer and Juliani (2016). Their LAUNCH Cycle model provides suggestions and guidelines for initiating and integrating design thinking into K-12 classrooms with students. The researcher modified a LAUNCH Cycle lesson plan template (see Appendix C) to build the lessons. The lessons were tied to phases in the LAUNCH Cycle, which framed the design challenge.

Implementation. Beginning in October of 2018, the study implementation occurred over a period of seven weeks. The researcher visited the classroom once a week for five weeks (skipping a holiday week), and twice one week. The duration of each lesson was generally 45 minutes to one hour. Most lessons were conducted early in the morning, after the classroom's morning routine. Lessons were followed by a student group interview and then the teacher interview.

Inspired by the aforementioned design thinking idea from d.loft, the researcher titled the design thinking challenge as Designing a Shared Space for Native Americans and Early Settlers. The activities in the challenge were adapted to fit third grade and the LAUNCH Cycle (Spencer & Juliani, 2016) framework. Following the framework, each classroom lesson focused on one

phase, except for lessons five and six, which were combined. Table 1 presents an outline of the lessons, activities, and classroom work associated with each lesson (see Appendix D).

Table 1

Designing a Shared Space for Native Americans and Early Settlers: Lessons Overview

Lesson/Phase	Activities Outline	Related Materials
Lesson 1: Role Play Debate *Phase 1: Look, Listen, and Learn*	• Teacher: Gaspar vs. Chief Role Play Debate - present character needs • Students: Take notes, develop interview questions in preparation to learn more about needs	Bio Sheets, Research Sheets, Press Conference Sheet, Top 4 Questions Sheet
Lesson 2: Press Conference *Phase 2: Ask Tons of Questions*	• Teacher: Introduce activity • Students: Press Conference - Ask Gaspar and Chief questions to learn more about needs	Top 4 Questions Sheet
Lesson 3 - Define Needs *Phase 3: Understand the Problem*	• Teacher: Introduce Venn Diagram activity • Students: Compare and contrast needs of Gaspar and Chief • Teacher and Students: Define needs statement	Venn Diagram Sheet
Lesson 4: Brainstorming *Phase 4: Navigate Ideas*	• Teacher: Introduce brainstorming activity • Students: Brainstorm ideas to solve defined needs statement	Brainstorming Board
Lesson 5: Build Maps and Revise *Phase 5: Create a Prototype* *Phase 6: Highlight and Fix*	• Teacher: Introduce prototyping and iterating activities • Students: Build maps, then receive feedback from Gaspar and Chief to iterate on maps	Maps
Lesson 6: Present Maps *Phase 7: Launch*	• Teacher: Introduce presentation task • Students: Present maps to class	Maps

Sources of Data and Data Collection Strategies

As it is important to gather evidence from many sources in case study research (Yin, 2018), a variety of data from the teacher and student participants were collected during the study. Data collection strategies included: interviews, observations, researcher field notes, and several

artifacts. According to Yin (2018), the use of multiple types of data sources enables the researcher to triangulate data and strengthen construct validity.

Researcher field notes. The researcher compiled a record of field notes throughout the study (see Appendix E). Field notes serve as a way to capture rich descriptions and study context through descriptive data (Phillippi & Lauderdale, 2018). Notes included descriptive as well as reflective information from observations and interviews. Documentation was also collected as a form of field notes.

Data from students. Data were collected from student participants before, during, and after design thinking activities. Strategies included various classroom artifacts, student self-assessments (pre and post), self-reflections, photographs, observations of activities in the classroom, and informal group interviews.

Artifacts. Several types of physical artifacts were collected during the study. The researcher collected artifacts including student work examples from each phase, photographs of classroom implementation, and self-assessment checklists and self-reflection questions completed by students. Artifacts provide the researcher with insight into cultural features and technical operations (Yin, 2018). Examining a wide range of artifacts also allows the researcher to develop a broader perspective of the topic over the course of the study (Creswell, 2007; Yin, 2018).

Four Cs checklist. In the form of a self-assessment, the Four Cs checklists (see Appendix F) were employed as a tool for students to assess their own skills development. These checklists served as a foundation for defining what could be perceived as growth in critical thinking, communication, collaboration, and creativity. The researcher developed each checklist based on the coordinating skill definition from the Partnership for 21st Century Learning (2015).

Adaptations from the Partnership for 21st Century Learning (2015) were made to fit the study context. For example, the checklists reflect an appropriate format and language for third grade students taking a self-assessment. The participating teacher also provided insight into developing an appropriate self-assessment for this grade level, based on students' previous experiences with self-assessments. Each skill was presented with a visual representation and asked students to answer, How am I doing? Students selected from: (a) yes, (b) starting to, or (c) not yet. The self-assessment provided data, similar to a pre-assessment, before the first design thinking activity. Students completed the self-assessment a second time following completion of the entire design thinking challenge. This data provided the researcher with insight into students' perceptions of their skill development in the Four Cs after the design thinking challenge.

Self-reflections. Upon completing participation in the design thinking challenge, students were asked to complete a self-reflection (see Appendix G). The self-reflection presented four questions focused on gaining insights into students' experiences during the study. While student data regarding the Four Cs was captured in the self-assessments, questions in the self-reflection specifically aimed to gather data on the design thinking experience. Students recorded handwritten answers to the questions in a narrative format.

Student work. Throughout the design thinking phases, the researcher collected student work from students. Any work completed by students during the lesson activities, such as notes or worksheets, was collected. In particular, the researcher collected the completed lesson activity materials that were created for the study, including the bio sheets, research sheets, press conference sheets, top four questions for press conference sheets, Venn Diagrams, brainstorming boards, and maps.

Direct and participant observations. As this study took place in a real world setting (Yin, 2018), direct observations and participant observations were recorded as sources of data. For direct observations, the researcher captured detailed descriptions of what occurred in the context of the study. The record of events provided an incontestable description, which was applied for further analysis (Stake, 1995). The researcher described the context of the physical situation, such as the classroom environment and detailed accounts of student participation, as best as possible in order to provide additional information about the study (Stake, 1995; Yin, 2018).

In addition to direct observations, a participant-observation technique was practiced. Participant-observations allow the researcher to play a functional role within the field, granting her access to most often inaccessible data, and gain a perception of someone in the study rather than external of the study (Yin, 2018). When applicable, the researcher participated in the study mirroring a teacher-role in an effort to gain insight into interpersonal behaviors and motives. Both direct observations and participant-observations were recorded in field notes during each phase of the design thinking challenge.

Informal interviews. Yin (2018) described interviews as one of the most important sources for case study evidence. To understand the event from the perspectives of students, six informal group interviews were conducted after each lesson during the design thinking challenge. The researcher lead unstructured interviews (Weiss, 1995), which resembled guided conversations. While leading with inquiry, the researcher was careful to ask unbiased, open-ended conversational questions. Yin (2018) described this interview approach as asking good questions, being a good listener, staying adaptive, having a grasp of the issue, and conducting research ethically. By taking an unstructured approach, the researcher had the ability to ask about events or facts, which were used to further corroborate data (Tellis, 1997).

Since the informal interviews were conducted with children, the researcher had measurements in place to ensure student participants felt comfortable and safe in the environment. The researcher spent time developing friendly relationships with students in the classroom. The researcher also ensured students felt comfortable sharing in a group setting. Additionally, interviews took place in the familiar location of the classroom so students would not feel wary to share information.

Although interviews were unstructured and informal, an interview protocol was followed to strengthen reliability of the study. The researcher initiated the line of inquiry using the protocol, but remained open and adaptable by using follow-up or probing questions. The Student Interview Protocol (see Appendix H) was used as a tool for beginning a conversation with students to explain their experiences. Upon receiving permission from the school, interview data were captured in an audio format allowing the researcher to focus on the questions.

Data from the teacher. While majority of the data for this study were from students, data were also collected from the teacher. Collecting data from the teacher allowed for the researcher to analyze a comprehensive experience for this study. Teacher data collection strategies included gathering artifacts, direct observations, and multiple interviews.

Artifacts. A collection of physical artifacts was gathered from the teacher participant throughout the study. Artifacts included photographs of instruction, lesson plans, and a pre- and post-self-reflection completed by the teacher.

Pre-and post-self-reflection. To gain an understanding of the teacher's knowledge and perspective, the teacher completed a self-reflection (see Appendix I). The goal of the self-reflection was to collect the teacher's insights on the study's theoretical frameworks: 21st century

skills and design thinking. Before and after the study, the teacher recorded handwritten answers to the two questions posed in the reflection.

Direct observations. Similar to the student data source, direct observations were made around teacher interactions. Observational notes described the implementation of the lesson plan during the time it took place. The researcher also recorded student-teacher interactions and facilitation techniques by the teacher. The researcher added reflective notes about the student-teacher interaction during the design thinking activities. In parallel with student observations, the teacher observations were recorded in the researcher's field notes.

Interviews. The researcher conducted six semi-structured interviews with the teacher after completing each lesson in the classroom. The interviews took place on the school site on the same day as the lesson implementation. Since interviews provide personal explanations and perceptions (Yin, 2018), they are helpful to understanding the implementation of the design thinking learning activities. The teacher interviews followed the approach of a guided conversation, with a goal of exploring themes relevant to the study.

The Teacher Interview Protocol (see Appendix J) focused on the study's research questions and reflected content from the Four Cs checklists. As encouraged by Creswell (2014), the researcher followed the interview protocol and asked questions to initiate the discussion, then followed-up with probing questions for elaboration. Data were recorded using an audio recorder and notes were written in the researcher's field notes.

Human Subjects Considerations

The subjects of this study included students in a third grade classroom and their teacher. Ethical procedures were practiced in order to make participants feel safe and to ensure that data from minors was handled efficiently. Teacher and student participant data, such as names and

location, were only available to the researcher. During data analysis, the researcher changed the student participants' names to pseudonyms to protect their anonymity. The teacher name and school site were also never recorded, shared, or reported. The focus of the study was to explore the impact of design thinking on any elementary school student, not to evaluate these students, the teacher, or school, specifically. Additionally, records were stored in secure, private locations. The researcher secured any physical evidence in her home safe. Word processing documents were stored on the researcher's personal and private computer, guarded by a password.

Prior to commencing the study, a formal review of the research proposal was conducted by Pepperdine University's Graduate School Institutional Review Board (IRB). This study qualified as exempt research (US Department of Health and Human Services, 2009) by Pepperdine University's IRB (see Appendix K) in August of 2018. The study was considered exempt as it met the criteria for Category 1: Classroom Activities. Written permission from the school principal was obtained prior to study implementation. Since the study qualified as classroom instruction, notifications to parents were not necessary.

Following approvals from Pepperdine University's IRB and the participating school, the teacher was presented with a study information sheet. The sheet included information about the purpose of the study, participant involvement, participation withdrawals or alternatives, confidentiality, researcher's contact information, and rights of the research participants. The confidentiality section ensured the teacher participant all participants would remain anonymous, data would be stored in a secure location, and any identifiable information would either be disguised or remain confidential.

As indicated, ethical measurements were also in place while the researcher was in the classroom for data collection. There was potential for student subjects to feel nervous with the

addition of the researcher, someone unknown, observing the classroom and conducting interviews. To establish a safe environment for students, the teacher introduced the researcher to the students and described the purpose for her time spent in the classroom. Additionally, in an effort to cultivate familiarity the teacher facilitated all design thinking lessons. Interviews conducted with students were informal and took place in the classroom to ensure a safe, comfortable location for all participants.

Study Validity

Lincoln and Guba (1985) suggest a qualitative study must establish trustworthiness to warrant the validity of the research. Trustworthiness can be granted by establishing procedures for credibility, transferability, dependability, and conformability (Lincoln & Guba, 1985). This study applied these principles to establish validity.

To construct credibility, the researcher visited the school site for prolonged periods of time to understand the context and establish relationships with the students and teacher (Creswell, 2014). Rigorous data analysis was conducted on the interview transcripts, reflections and assessments, artifacts, and field notes. Multiple iterations of analysis and the use of a peer-reviewer ensured accuracy of narrative data interpretation. Triangulating data sources and types of data further strengthened credibility (Creswell, 2014). Providing information about the context of the study supports transferability. Although participant profiles were anonymized, a reader understands the classrooms context of third grade and the student to teacher ratio. Also, a reader understands the level of design thinking experience from the teacher before the study. Thus, it is possible for the study to be transferable to a different research context.

Dependability is strengthened through research insights and protocols (Creswell, 2014; Yin, 2018). Readers can gather insight into the research problem and process through the

chapters laid out in this proposal. The data collection protocols described in this chapter provides readers with methods for replicating the study. Conformability is strengthened by practicing reflexivity throughout the study (Creswell, 2014). At various times, the researcher recorded self-reflections in her field notes in effort to clarify bias. This contributes to the accuracy of interpretation and supports internal study validity.

Data Analysis

As this study collected data from multiple sources, the researcher followed a holistic approach to analyzing the data. A holistic approach offers the ability to capture a comprehensive picture of the case (Stake, 1995). Although each data source required individual, in-depth analyses, the researcher treated the case as a whole. This section discusses the processes for data analysis.

Analysis of interviews, student self-reflections, and researcher field notes. The narrative data, which consisted of the teacher and student interviews, student self-reflections, and researcher field notes, was analyzed in the *HyperRESEARCH* software program. This qualitative analysis software aids analysis (Creswell, 2014; Richards & Morse, 2012; Yin, 2018) and provides documentation of the process. The researcher prepared the data for analysis by changing all of the students' names to pseudonyms to protect their identities. This document was stored in a separate location from the study files. The 12 students and teacher's (six interviews per group) audio interviews were transcribed using *HyperTRANSCRIBE*. The transcripts were uploaded into *HyperRESEARCH* and organized into two cases, one for the student source files and one for the teacher source files.

To prepare the student self-reflections, the researcher transcribed the handwritten responses to word processing documents. Responses were organized to reflect one question per

file. The four files were imported into the same *HyperRESEARCH* case for students. Next, the researcher created a separate case for her field notes in *HyperRESEARCH*. First, she prepared her field notes by changing any names to pseudonyms, and then imported the notes into the case file. The researcher reviewed all files to ensure they reflected the correct content and were organized accordingly.

For analysis, the researcher played with the data to explore patterns, insights, or promising concepts (Yin, 2018). Data were also explored using visual displays or frequency tables (Miles, Huberman, Huberman, & Huberman, 1994). Exploring the data in this manner allowed the researcher to work towards a general analytic strategy. While working through the data, the researcher also applied the analytic technique called pattern-matching. In pattern-matching, data from the case study are compared to the data predicted before the study begins (Campbell, 1975; Yin, 2018). As indicated, this study was designed with the theoretical proposition that design thinking cultivates 21st century skills, the Four Cs: critical thinking, communication, collaboration, and creativity. Therefore, the researcher explored data that linked to these four categories. According to Yin (2018), internal validity is strengthened if the researcher successfully finds patterns between the empirical and theoretical data.

Additional codes or categories may be added while the researcher classifies and interprets the data (Creswell, 2007). A fifth code category emerged during analysis, as well as several sub-codes for each of the categories. From the first few data reviews, the codebook was generated along with the definitions. To ensure the reliability of the codebook and narrative interpretations, the analysis process and results were peer-reviewed by an experienced researcher. After discussing and applying several modifications, both researchers agreed coding was accurate.

Analysis of student pre-post self-assessments. The data from the pre- and post- student self-assessments, the Four Cs checklists, were analyzed using descriptive quantitative measures. First, the researcher prepared the data by creating a spreadsheet outlining the questions. Student responses from the pre- and post- self-assessments were recorded in the spreadsheet, and then sums were determined. The researcher created several tables to help calculate the sums and percentages of the assessments. Tables were created for the pre-assessment, post-assessment, and comparison of pre-post. The researcher analyzed changes between the pre and post self-assessments to determine an increase or decrease in skills development.

Analysis of student artifacts. As described, student artifacts were also collected during the design thinking challenge. A total of six student artifact types, student work from the lessons, were collected for analysis. First, the researcher defined a simple scoring guide for each artifact type. Although the criteria were dependent on the artifact, the performance levels remained the same for each artifact: (a) exceeds expectations, (b) meets expectations, (c) developing skills, and (d) needs improvement. Then, the researcher organized the artifacts by type for analysis. During analysis, the researcher evaluated and scored each artifact based on the defined criteria.

Analysis of teacher pre-post self-reflection. The teacher completed a self-reflection before and after the study. The self-reflection posed two questions, focusing on the study's theoretical frameworks: 21st century learning and design thinking. To prepare for data analysis, the researcher transcribed the handwritten responses to a word processing document. Then, the researcher identified changes from the pre and post responses.

Presentation of Findings and Study Conclusions

The presentation of findings is organized by findings from the student sources, findings from the teacher sources, and findings from the researcher's field notes. Qualitative data from the

interviews and self-reflections are presented thematically, in a narrative format with descriptions and quotations for support. The teacher self-reflection is shared in a narrative format and also supported by descriptions and quotes. The descriptive quantitative data from the student self-assessments is presented in tables and a discussion of the findings. The evaluation of student artifacts is illustrated in tables and followed by a discussion of findings. Field notes are presented in a narrative format, with a focus on themes from the codebook. Study findings and conclusions are shared in Chapters Four and Five.

Chapter Four: Findings

The purpose of this exploratory case study was to describe the process and outcomes of implementing a design thinking process into learning activities within an existing curriculum for students in elementary school classrooms. During the Fall of 2018, the researcher partnered with a third grade teacher to implement the design thinking process in his classroom. Integrating the design thinking process as a pedagogical framework into existing curriculum was investigated as a way for teachers to cultivate 21st century skills, characterized by the Four Cs: critical thinking, communication, collaboration, and creativity (Partnership for 21st Century Learning, 2015).

This study included the gathering of various types of data from the teacher and students during the classroom design thinking implementation. The sources of data included student and teacher interviews, researcher observations, pre- and post- student self-assessments, student self-reflections, student artifacts, and a pre-and post- teacher self-reflection. The central guiding research questions and sub-questions were as follows:

Central Guiding Research Question:

- How does implementing the design thinking process into learning activities with elementary school-aged children foster the development of critical thinking, communication, collaboration, and creativity?
- Questions Related to Student Participants
    1. What does it look like for students to engage in design thinking learning activities in the classroom?
    2. How do students perceive design thinking learning activities?

3. Do students demonstrate critical thinking, communication, collaboration, and creativity skills while participating in design thinking learning activities? If so, how?

- Questions Related to the Teacher Participant
  1. How does the involved educator believe the use of design thinking contributes to the acquisition of critical thinking, communication, collaboration, and creativity in an elementary school classroom?
  2. What challenges does the educator anticipate for implementing design thinking within instructional plans?

This chapter presents findings for the teacher participant and 25 student participants. The chapter is organized as follows: (a) participant profiles, (b) student findings, (c) teacher findings, and (d) researcher observations.

Participant Profiles

The participants in this study included one teacher and the 25 students in his third grade classroom. The study was conducted in the Fall of 2018, towards the beginning of the school year, therefore the students and teacher worked together for about two months before the study commenced. Information about each participant group is described in this section.

Student participants. The participating classroom consisted of 25 students. The students were in third grade, and ages ranged from eight to nine years. Of the 25 participants, a little less than half (48%, $n = 12$) were male, and a little over half (52%, $n = 13$) were female. Two students (8%) were considered English Language Learners, and two students (8%) were considered special population. As a measure to protect students from the school, little demographic data were available for the student participants in this study.

Teacher participant. The teacher participant was a male, veteran teacher with 26 years teaching experience at the same school. The teacher had experience teaching grades first to fifth. The study was completed during the teacher's seventh year teaching third grade. Although the teacher is on a team with three other third grade teachers, he was the only teacher involved in this study.

Student Group Interviews and Self-Reflection Questions

Narrative data from 25 students include responses from six group interviews, each group consisting of four to five students, and four written self-reflection questions. Interviews were completed after each of the six lessons. Each lesson focused on one phase in the design thinking LAUNCH Cycle (Spencer & Juliani, 2016), except for phases five and six, which were combined to mirror the implementation of the lessons. The duration of each interview ranged between five to ten minutes. Interviews were conducted within the students' design thinking groups. Groups alternated meeting with the researcher for every interview, allowing for a wider representation of students from the class. As a result, 88% (n = 22) of students are represented in the interview data. Due to attendance variations or other classroom requirements, 12% (n = 3) of students from the class did not have the opportunity to meet with the researcher for an interview. Attendance variations also impacted the representation of students for the self-reflection questions. A total of 22 (88%) students completed the self-reflection questions after the challenge was finished. The students who were unrepresented in the self-reflections were different from the students unrepresented in the interviews.

Analysis of all the interview data and student recorded self-reflections resulted in 210 codes, which were further organized into five skills: (a) collaboration, (b) communication, (c) creativity, (d) critical thinking, and (e) design thinking. Themes were also defined within each

skill. The defined skills and related themes are presented in Tables 2 to Table 6, in addition to descriptions and student participant quotes.

Skill One: Collaboration. As the nature of the design thinking challenge was collaborative, students were asked several questions relating to working in groups during interviews and self-reflections. At times, responses related to collaboration emerged even when it was not directly addressed. Of the 210 coded passages, 72 of them resulted in coded passages highlighting collaboration. Within the provided responses, four themes emerged: (a) collaborative experiences, (b) collaborative outcomes, (c) engagement, and (d) shared responsibilities. Table 2 presents the described category and associated themes.

Table 2

Student Collaboration Skills

Skill	Themes
Collaboration (*N* = 72)	Collaborative Experiences (*n* = 33) Collaborative Outcomes (*n* = 14) Engagement (*n* = 14) Shared Responsibilities (*n* = 11)

Collaborative experiences. Thirty-three of the 72 coded passages were coded as collaborative experiences. Many of the responses described a student's collaborative experience as being joyful or as having fun working together. During the interview after the combined Create a Prototype and Highlight and Fix phase, one student described: "I liked how we got to share our ideas with other people in our group" (Liam). During the interview for the Look, Listen, and Learn phase, another student expressed the enjoyment of working in groups with friends: "I think it was really fun because I got to work with my friends" (Joan).

During the last interview after the *Launch* phase, when asked what they enjoyed most about the challenge, students' comments highlighted working together: "I enjoyed the presentation and making the map because I like working in a group" (Maggie). "Making the maps because I liked working with the partners and getting together and working together" (Gail).

Students worked in groups for much of the experience. Since there were 25 students, group sizes consisted of five groups of four and one group of five. Several students described their collaborative experience as working well together when asked what it was like working with the group during the self-reflections. Fifteen of the students generally described their particular group as working well together. Two students shared examples of how their group worked together: "I worked pretty good with my group because we were all cooperating and we said, "that is a good idea, but…" (Sally). "The group worked well together. We did not fight over who would draw what. We all agreed what we would draw" (Kristy).

While majority of the coded passages shared similar sentiments to the comments above, a few students expressed the challenges of collaboration or described it as being hard. During the self-reflection, when asked, "What did you learn from this experience?" one student proclaimed: "I learned that teamwork can get too hard" (Gabe).

***Collaborative outcomes*.** Fourteen of the 72 coded passages were coded to describe outcomes of working collaboratively. Many students revealed collaboration could result in a better product. During the last interview, when asked what they enjoyed about the experience, one student described that he "enjoyed the presentation and making the map," then added: "Can I add something to mine? If we didn't do it together it would be hard to make a map just by myself, but with a group we could do it faster if we work together" (Gail).

During the self-reflection, when asked to share what they learned from the experience, two students described how working together is better: “I learned that working together in a group is better because we would all have good ideas and we can make it into one or a lot of awesome ones” (Jenny). “I learned that working together is very powerful” (Pauline).

In response to the same question, some students expressed they learned teamwork as a result of the experience. Two comments from students include: “I learned to work with people better” (Liam). “I learned that we have to work together and take risks” (Gail).

Engagement. The theme of engagement surfaced through students’ comments as they described activities during interviews. Of the 72 coded statements, 14 of them were about engagement. Many of the passages revealed positive individual or whole group engagement. One passage from the *Ask Tons of Questions* interview, recounted a student’s positive individual engagement as she shared her excitement about the activity: “We asked Chief Chowig and Gaspar de Portola questions and I had a million of them” (Megan).

During the Look, Listen and Learn interview, one student shared how everyone in the group was engaged: “We were all participating and doing what we thought we should do” (Paul).

A few of the coded passages revealed a lack of individual engagement, whether from the student themselves or from someone else in their group. Most of those passages were in regards to another student who was not engaged. During an interview, one student shared: “I didn’t like that Leopold kept getting distracted, since we were next to the blue table and they were talking a little louder than us” (Jasmine). During the self-reflection, one student also reported a group member’s lack of engagement: “We worked really well in our group, but one person was barely doing anything” (Marietta).

Shared responsibilities. Students also reported how they shared responsibilities amongst the group, resulting in 11 of the 72 coded passages. Majority of the coded passages were from interviews and focused on shared decision-making amongst students in a group. On several occasions, students were asked to describe how decisions were made in the group. When asked how their group decided to narrow down to the top four questions during the Look, Listen, and Learn interview, one student described: "We each shared one for each and then we did another for the other section. We shared all of ours and then the other team did, and we decided which ones we liked best" (Paul).

Two other students described how their groups made decisions during other interviews: "Someone would say, 'Well, how about this idea,' and then someone else would say, 'Well, would that work?' politely, and like talk about it" (Faith). "Yeah, we asked everybody what they knew about on the map and then we just had people that knew most about each thing would share those things" (Gail).

A few of the students described taking turns as a process for sharing responsibility within the group. Students shared: "People were taking turns when we were sharing out our ideas" (Chuck). "Someone would say, 'You can go first'" (Faith).

Skill Two: Communication. Students were required to communicate throughout the design thinking process to achieve tasks in the activities. Although communication emerged as a skill, it contained the smallest number of coded responses, resulting in 17 of the 210 student coded responses. Within communication, two themes were identified: (a) articulation of ideas, and (b) presentation experiences (see Table 3).

Table 3

Student Communication Skills

Skill	Themes
Communication (*N* = 17)	Articulation of Ideas (*n* = 5) Presentation Experiences (*n* = 12)

Articulation of ideas. The theme of articulation of ideas transpired during the Launch interview where groups of students presented their maps. The coded passages highlighted students' challenges with articulating ideas aloud to the class. When the researcher asked students if the presentation went as planned, one student expressed concern: "Not really because it didn't go as we planned because we were thinking we were going to explain more but we didn't really have enough things to share so we didn't really say a lot of things" (Maggie).

When asked what they liked or disliked about the presentations, two students expressed it was hard to explain details to the class: "It was hard talking about some of the stuff where we knew what we drew but kinda hard to explain because you are in front of a group" (Chuck). "And also some of our things didn't have that much detail to them and a lot of them was hard to like give details about and stuff so it was hard" (Gabe).

Presentation experiences. Twelve of the 17 coded responses pertained to students' presentation experiences. Responses derived from two self-reflection questions and the last interview. During the Launch interview, two students reacted positively towards the presentation experience when asked what they liked or didn't like: "I liked talking about the map and presenting it and stuff" (Gabe). "Explaining the map because we got to talk about the stuff that was on there and explain what is was" (Chuck). Another student claimed she, "…was kinda shy" then proceeded to say, "I kinda like it" (Maggie).

There were also several indications of the presentation experience in the self-reflection questions. Some students described the presentation as a creative risk: “Some creative risks that I took were doing presentations in front of the class” (Marietta). “Being brave. Talking to my classmates” (August).

When asked their favorite phase from the LAUNCH Cycle, five students claimed the presentation, Launch phase, as their favorite: “The best phase is to present it to people because it was fun and calming” (Liam). “The presentation. It was the best because it was a little easy to do” (Pauline). “The big speech, because our group worked together in the big speech” (Jasmine).

Skill Three: Creativity. As design thinking stems on building creative solutions to complex problems, there were several responses about the creativity process. Creativity was the second largest skill, resulting in 58 of the 210 student coded passages. Five themes emerged within the coded responses: (a) idea creation, (b) iteration; (c) prototyping, (d) risk taking, and (e) sharing ideas. Table 4 presents the skills and described themes.

Table 4

Student Creativity Skills

Skill	Themes
Creativity (*N* = 58)	Idea Creation (*n* = 6) Iteration (*n* = 5) Prototyping (*n* = 33) Risk Taking (*n* = 6) Sharing Ideas (*n* = 8)

Idea creation. Some of the coded responses described the students’ experiences of creating new ideas. After defining the needs statement during the Understand the Problem phase,

one student described their group already started brainstorming how to address the problem: "Yeah, making sure they are helping each other equally" (Danielle).

After the Navigate Ideas phase, one student explained an idea from her group:

> We came up with an idea about how they can share the land. We drew a river in the middle of the land. So one group would be on one side of the land and the other group could be on the other side of the land, so if they got into a fight when they were fishing in the river there would be two sides of the river so one side would get fish on their side and the other would get fish on their side (Sally).

During the combined Create a Prototype and Highlight and Fix interview, one student described his group's prototype idea: "We mapped out stuff like how they are going to share land and how they will get along. We started with a river and a bridge" (Ben).

Iteration. As iteration is a focus during the Highlight and Fix phase, some of the coded responses coordinated with the task of iterating. Responses were coded from both the interviews and self-reflection questions. During the combined Create a Prototype and Highlight and Fix phase, one student described how his group made revisions: "We erased the mission house on Chief Chowig's side and we erased the farm on Gaspar de Portola's side" (Ben)

Some of the coded responses demonstrated a student's enjoyment of iterating. When asked which phase was their favorite during the self-reflection, a few students declared the Highlight and Fix phase: "Highlighting and fix so the things we didn't need we will fix the mistake" (Minnie). "The best phase of the launch cycle for me was the highlight and fix because we got ideas of what we need to do and draw" (Marietta).

Although there were students who enjoyed the process of iterating, challenges were also expressed. During the Launch interview, one student described challenges associated with iteration during the presentation: "Well, we didn't really have enough time because someone was

adding more to the map so then while we were talking we just added things while we were thinking" (Maggie).

Prototyping. Thirty-three of the 58 coded responses were about the process of prototyping. This theme appeared as students expressed the enjoyment of prototyping or described it as taking a creative risk. During the combined Create a Prototype and Highlight and Fix phase, several students described enjoyment in prototyping since they were able to draw and share ideas: "I liked that we could draw pictures so that we could explain it more to our group" (Sally). "I liked that we could share our ideas" (Faith).

When asked what they were enjoying about this challenge during the same interview, one student described prototyping as fun and helping pass time: "It's fun and right now it goes really fast. It passes time and it's actually really fun" (Liam). When asked to elaborate on why it was fun, another student chimed in: "So like having an idea and writing it down" (Ben).
Then, the previous student elaborated how he liked bringing his ideas to life: "Instead of just like writing something down like a plan and you don't actually get to do it" (Liam).

When asked which phase was their favorite during the self-reflection, about 40% of responses named the Create a Prototype phase: "Phase Five Create a Prototype because I love the buildings and resources and drawing" (Megan). "The best phase for me was probably the Create a Prototype because the whole group got to work together and share ideas" (Jenny). "Making our map was the best for me because I love drawing with other people and I'm good at teamwork" (Kristy).

More than 75% of the students described activities from the Create a Prototype phase as a creative risk. When posed with the question, "What were some creative risks that you took," during the self-reflection, students shared: "A creative risk I took was when I wasn't so sure

about putting a river in the middle but we did it" (Sally). "I took a creative risk when I didn't know how to make a split between their land" (Kathy). "Making a prison for people that don't work" (Martin). "With the teepee for Chief Chowig we didn't know if he liked it or not" (Jasmine). "We didn't really know if we should have put a mission but we took a risk and drew it" (Jenny).

Risk taking. Responses were coded as risk taking when students revealed original ideas, or when students described experiences as taking risks. Responses from this theme resulted in six of the 58 student coded passages. When asked what they learned from this experience during the self-reflection, two students expressed: "I learned that if we take a risk it actually would be fine" (Danielle). "I learned that we have to work together and take risks" (Gail).

During the Create a Prototype and Highlight and Fix interview, when asked if they felt like they could be creative, one student explained creative ideas that reflected originality: "Yeah, I feel like we were pretty creative because we thought of some really creative ideas, like a rabbit, a mission, a weapon cabinet, a shed, and a garden" (Liam).

Sharing ideas. The theme of sharing ideas was identified as students described how they communicated new ideas to each other. Some of the coded responses revealed success in sharing ideas, while other students reported challenges associated with the process of sharing ideas. When asked how well they worked with their groups during the self-reflection, a few students described how sharing ideas contributed to the ability to work well together. Two students noted: "I think we worked together good because we all had good ideas and we all shared them and worked together" (Jenny). "I work pretty good with my group. The good parts were when we shared ideas" (Liam). Also during the self-reflection, one student described the importance of

sharing as something they learned from this experience: “I learned that sharing is important even as you are scared to share” (Megan).

During a few interviews, some students expressed challenges with the process of sharing ideas. One student shared a challenge as figuring out where to start during the Navigate Ideas interview, “Yeah, but some of us were kinda sharing ideas and we didn’t show what to start with” (Faith).

In a different interview, another student shared a similar sentiment while describing the process of sharing ideas during prototyping:

> It may have been a little challenging at times because like when someone burst out with an idea people would say, “okay, let’s do that,” but when somebody else had another idea we would do that and forget about the other idea (Liam).

Skill Four: Critical thinking. Critical thinking appeared as a significant skill as students described their thought processes during the design thinking activities. Of the 210 student codes, 28 of them were coded as critical thinking. During many activities, students were provided with opportunities to make decisions, draw conclusions, analyze information, and ask good questions. Thus, four themes were identified for this skill: (a) decision-making, (b) drawing conclusions, (c) information analysis, and (d) inquiry (see Table 5).

Table 5

Student Critical Thinking Skills

Skill	Themes
Critical Thinking (*N* = 29)	Decision-Making (*n* = 6) Drawing Conclusions (*n* = 12) Information Analysis (*n* = 6) Inquiry (*n* = 5)

Decision-making. Responses related to decision-making appeared in both the interviews and self-reflections, resulting in six of the 29 coded passages. Although one student reported a successful experience, most of the responses identified challenges in how their groups made decisions. During the Look, Listen, and Learn interview, one student described decision-making as easy for her group: "Well when we were all thinking about it we actually decided really quickly so that was the easy part" (Marietta). As described, most of the coded responses reported challenges associated with making decisions.

During the self-reflection, when asked how well they worked with their groups, two students noted: "We worked very well but it was hard to agree on things when we were drawing" (Maggie). "I think it was ok, but it was hard to focus. We all had lots of ideas to do and we did almost all of them" (Danielle).

When asked to describe a creative risk, another student shared he did not agree with his group, but they proceeded with the idea anyway: "The prison made me nervous because they always went with the idea and I never agreed" (Gabe).

Drawing conclusions. The theme of drawing conclusions emerged as students described examples of making inferences, making connections, and interpreting information in their responses. Of the 29 coded passages, about 12 of them were coded as drawing conclusions. In some responses, some students addressed how they made an inference to determine meaning.

During the Look, Listen, and Learn interview, one student described the need to make inferences for thick questions when asked what they liked or disliked about the activity: "I think it was challenging, but also a little easy because sometimes there were thick questions and we had to use the text to find out" (Paul).

During the same interview, another student made and inference about the natives clothing: “Well, I do know that some clothing of the Indians came from rawhide. I do know that…and maybe some bones” (Leopold).

The process of making connections and interpreting information to draw conclusions resulted in most of the codes for this theme. When asked to describe what they learned from the press conference activity, one student concluded: “They were only a little bit friends, but you can’t make someone do what you want them to do” (Megan).

During the Understand the Problem interview, one student shared something she learned from that day’s activity: “I learned that Chief Chowig is a brave man” (Danielle).
When asked, “What did you learn from this experience?” during the self-reflection, several students drew conclusions by reporting: “I learned that Chief Chowig and the Spanish had a fight” (Jasmine). “I learned about how Chief Chowig and Portola both needed resources (Marietta). I learned that everyone has different needs and sometimes need to be alone” (Paul). “I learned that Chief Chowig and Senor Portola had a hard time sharing” (Kathy).

Information analysis. Throughout several interviews, students shared examples of analyzing evidence or different points of view. These responses were coded as information analysis and resulted in six of the 29 coded passages. Majority of these responses were from the first interview in the Look, Listen, and Learn phase. During this interview, one student described the native’s point of view: “I think it made them feel bad because they lost some of their family members” (Jasmine).

During the same interview, another student shared his understanding of both points of view: “I learned that the people that came from Spain, they thought they were helping the Indians but they were really making them work harder for them” (Paul). After the press

conference activity, another student evaluated both points of view by sharing: “They were only a little bit friends, but you can’t make someone do what you want them to do” (Gabe).

Some coded responses highlighted difficulties in analyzing information. Majority of the challenges were coded from the Understand the Problem interview, where students completed a Venn Diagram and needs statement. The researcher learned students had previous experience with a Venn Diagram, but they had not focused on establishing the needs in their previous experience. One student described completing the Venn Diagram as confusing, by sharing: “It was a little confusing because the same part was okay but the needs were a little hard” (Kathy). For the same activity, another student shared: “It was hard” (August).

Inquiry. Students experienced the process of generating and asking questions during the Ask Tons of Questions phase. Five of the 29 coded passages were highlighted as inquiry. Several of the students’ responses expressed enjoyment in the experience of asking questions. During the Ask Tons of Questio*ns* interview, one student shared: “It was fun. I liked asking questions and I liked that I got to lay down when I asked questions” (Martin).

When asked which phase students liked best and why, three students reported liking the Ask Tons of Questions phase. Two of those responses included: “The best part of the Launch cycle for me was when we were supposed to ask a ton of questions, because I like to learn new things so I ask a log of questions” (Sally). “The ask tons of questions was the best for me because I would ask a lot of questions if I didn't understand what they were saying or showing” (Kathy).

Skill Five: Design thinking. Since design thinking was employed as the instructional process for this study, students made many comments about the associated activities during interviews and self-reflections. Out of the 210 coded passages, 34 of them were coded as design

thinking. While analyzing the student data, one theme emerged, student reflections on design thinking, for this skill. Table 6 presents the skill and described theme.

Table 6

Student Design Thinking Skills

Skill	Themes
Design Thinking (*N* = 34)	Student reflections on Design Thinking (*n* = 34)

Student reflections on design thinking. Throughout interviews and reflections, students reported several reflections on design thinking. Reflections focused on whether or not students would want to do this again, how design thinking is a different type of experience, and the time constraints associated with the activities. When asked, Would you want to do this again? during the self-reflection, 17 of the 22 students exclaimed wanting to do this again in the future. Only one student had a negative reaction, and the remaining simply did not address that part of the question. Some of the positive responses include: "Yes, I would love to do this again" (Marietta). "I really want to do this next time" (Martin). "Yes, I would want to do this again" (August). "Yes, I would like this to happen again" (Megan).

Several of the coded responses revealed students' perceptions of how design thinking is a different type of learning experience. After the Create a Prototype phase, two students from the group described how the activity was different from other activities in class: "Um, so like we did get to draw our ideas because we usually just have to share them. That was different" (Jenny). "So like having an idea and writing it down. Instead of just like writing something down like a plan and you don't actually get to do it" (Ben).

When asked what students may have liked or disliked during the Understand the Problem phase, another student emphasized the ability to do something with their ideas as different: "I liked that we got to learn a different one and that we didn't just have to think about it and tell it" (Danielle). The notion was further emphasized during the prototyping interview when another student described the different materials used: "We used different stuff, like cardboard and sticky notes" (Faith).

During two different interviews, students also shared time constraints of activities. After the Ask Tons of Questions phase, one student shared: "I think we could've had more time because I have a lot of questions, like every day I have more questions. I kept thinking of more and more questions" (Megan). Another student expressed a concern about not having enough time during the prototyping and revision phase: I just really didn't like that it felt like we had no time at all. I wanted more time to do stuff" (Liam). Another student shared like they needed more time to prepare for the presentation: "Well, we didn't really have enough time because someone was adding more to the map so then while we were talking we just added things while we were thinking" (Kristy).

Student Pre-Post Self-Assessments

In an effort to identify self-perceptions in development of skills relating to the Four Cs, students completed pre-and post- self-assessments. The self-assessment was composed of 15 questions with three to four questions for each Four Cs skill. Students completed the same self-assessment before and after the study. All of the students in the class (100%, $N = 25$) completed the pre-self-assessment. Due to attendance variances, a majority (88%, $N = 22$) of students in the classroom completed the post-self-assessment. For each question, students were presented with a skill in the format of a sentence and visual representation. Students then responded to, "How am

I doing?" then selected one of the following choices for each skill: (a) not yet, (b) starting to, or (c) yes. Tables 7-10 present findings from the pre-self-assessment.

Pre self-assessments. The self-assessment collaborative skills included working well together, willing to be flexible, and sharing responsibility. As shown in Table 7, the collaborative skill starting with highest number of Yes responses was willing to be flexible, which was at 64% (n = 16). Sharing responsibility and working well together were about equal. Sharing responsibility was 48% (n = 12) and working well together was 44% (n = 11). The Not Yet student responses were low, with only 4% (n = 1), 4% (n = 1), and 16% (n = 4).

Table 7

Student Pre Self-Assessment: Collaboration

Question	Yes		Starting to		Not Yet	
	n	%	*n*	%	*n*	%
• I can work well with different people and groups.	11	44%	13	52%	1	4%
• I can be flexible, and I am willing to agree with my group so we can make decisions together.	16	64%	8	32%	1	4%
• I can share responsibility for work with my group. I value ideas from each group member.	12	48%	9	36%	4	16%

As indicated in Table 8, the communication skills included communicating thoughts and ideas, listening for meaning, using technology, and communicating in different environments. All of the communication skills began with over 50% of students responding Yes. The highest communication skill was using technology, which was at 60% (n = 15). Communicating thoughts and ideas and listening for meaning were similar. Communicating thoughts and ideas started at 56% (n =14) and listening for meaning started at 52% (n = 13). Communicating in

different environments started with the lowest number of Yes responses for the communication skills at 44% (n = 11).

Table 8

Student Pre Self-Assessment: Communication

Question	Yes		Starting to		Not Yet	
	n	%	*n*	%	*n*	%
• I can communicate my thoughts and ideas to talking to people or writing my ideas.	14	56%	6	24%	5	20%
• I can listen to figure out the meaning of something, like information or ideas someone is sharing.	13	52%	11	44%	1	4%
• I can use different types of technology for my projects.	15	60%	7	28%	3	12%
• I can communicate in different environments and for different reasons (like telling an idea, or motivating someone).	11	44%	7	28%	7	28%

Table 9

Student Pre Self-Assessment: Creativity

Question	Yes		Starting to		Not Yet	
	n	%	*n*	%	*n*	%
• I can use strategies to make new ideas (like brainstorming or drawing). I can create new ideas and improve my ideas.	14	56%	7	28%	4	16%
• I can communicate new ideas to other people. I can be open to ideas from other people.	19	76%	5	20%	1	4%
• I know that when I don't do something right it is an opportunity to learn. I understand that sometimes creativity is a long process of learning from mistakes.	9	36%	13	52%	3	12%
• I can bring creative ideas to life. I can turn my ideas into products that could help people.	4	16%	11	44%	10	40%

The creativity skills consisted of making new ideas, being open to new ideas, learning from mistakes, and turning ideas into products (see Table 9). Responses for creativity presented a range of skill assessment. Of the four creativity skills, communicating ideas started highest at 76% (*n* = 19) of students indicating Yes. The creativity skill with the lowest number of Yes responses was turning ideas into products, which was 16% (*n* = 4). Not only was turning ideas into products low, it had the highest "Not Yet" response out of the skills for the entire pre-assessment, resulting at 40% (*n* = 10). Making new ideas began at 56% (*n* = 14) and creativity as a process began at 36% (*n* = 9).

As shown in Table 10, the critical thinking skills included making decisions, thinking about impact, making connections, and solving problems. For the critical thinking skills, solving problems had the highest Yes response at 68% (*n* = 17). Almost half, 48% (*n* = 12), of the students responded Yes to making decisions, and about one-third, 32% (*n* = 8) of students responded Yes to making connections. Thinking about impact started out as the lowest number for the entire pre-assessment at only 4% (*n* =1) responding Yes.

Table 10

Student Pre Self-Assessment: Critical Thinking

Question	Yes		Starting to		Not Yet	
	n	%	*n*	%	*n*	%
• I can make different types of decisions (decisions based on facts and based on experiences).	12	48%	10	40%	3	12%
• I can think about how different things impact each other and how they work together.	1	4%	19	76%	5	20%
• I can think about other people's points of view. I can make connections between information. I can reflect on learning experiences and how I arrived to my conclusion.	8	32%	8	32%	9	36%
• I can solve problems in regular and new ways. I can ask good questions to understand different points of view.	17	68%	8	32%	0	0

Post self-assessments. Responses from the post self-assessment demonstrated a positive change in students thinking about their skill development (see Appendix L). Table 11 presents the comparison of the responses from the pre and post self-assessments. Overall, results indicated growth for almost every skill in each of the categories.

Table 11

Student Four Cs Pre-Post Self-Assessment Comparison

	Pre ($N = 25$)		Post ($N = 22$)	
Collaboration	Yes	Not Yet	Yes	Not Yet
• Working well with others	44%	4%	77%	0%
• Willing to be flexible	64%	4%	82%	4%
• Sharing responsibility	48%	16%	73%	0%
Communication				
• Communicating thoughts and ideas	56%	20%	68%	9%
• Listening for meaning	52%	4%	68%	0%
• Using technology	60%	12%	64%	0%
• Communicating in different environments	44%	28%	82%	9%
Creativity				
• Making new ideas	56%	16%	82%	0%
• Being open to new ideas	76%	4%	41%	4%
• Learning from mistakes	36%	12%	82%	4%
• Turning ideas into products	16%	40%	59%	14%
Critical Thinking				
• Making decisions	48%	12%	50%	9%
• Thinking about impact	4%	20%	41%	9%
• Making connections	32%	36%	59%	9%
• Solving problems	68%	0%	68%	0%

Student responses showed growth for all the collaboration skills. Working well with others had the most notable change, from 44% (*n* = 11) to 77% (*n* = 17) of students indicating Yes. Willing to be flexible increased from 64% (*n* = 16) to 82% (*n* = 18) and sharing responsibility increased from 48% (*n* = 12) to 73% (*n* = 16). Another important change was two of the Not Yet responses for collaboration skills decreased to 0%. Working well with others decreased from 4% (*n* = 1) to 0% and sharing responsibility decreased from 16% (*n* = 4) to 0%.

Responses for the communication skills also indicated growth for every skill. Communicating in different environments was the most noteworthy increase, from 44% (*n* = 11) to 82% (*n* = 18) of students indicating Yes. Communicating ideas and listening for meaning showed similar growth to each other. Listening for meaning increased from 52% (*n* = 13) to 68% (*n* = 15) and communicating idea*s* increased from 56% (*n* = 14) to 68% (*n* =15). Using technology grew from 60% (*n* = 15) to 64% (*n* = 14). Similar to the collaboration skills, two of the communication skills decreased to 0% of students responding Not Yet. Listening for meaning decreased from 4% (*n* =1) to 0%, and using technology decreased from 12% (*n* = 3) to 0%.

Students responded with an improvement to three of the four creativity skills, making new ideas, learning from mistakes, and turning ideas into products. In fact, two of the creativity skills showed some of the largest increases out of the entire assessment. Learning from mistakes doubled by increasing from 36% (*n* = 9) to 82% (*n* = 18) and turning ideas into products tripled from 16% (*n* = 4) to 59% (*n* = 13) of students responding Yes. Making new idea*s* increased from 56% (*n* = 14) to 82% (*n* = 18) and being open to new ideas decreased from 76% (*n* = 19) to 41% (*n* = 9). However, it is important to note the Not Yet responses for being open to new ideas remained at 4% (*n* = 1) for both the pre and post self-assessments.

Three of the four critical thinking skills improved and one skill remained the same. The critical thinking skills, making decisions, thinking about impact, and making connections, all showed growth. Most notably, thinking about impact had the largest increase for the entire assessment, from 4% (n = 1) to 41% (n = 9). Making decisions grew from 48% (n = 12) to 50% (n = 11) and making connections increased from 32% (n = 8) to 59% (n = 13). Solving problem*s* remained the same for both Yes responses at 68% (n = 15) and Not Yet responses at 0%.

Student Work Examples

Student work from the classroom was collected during each design thinking phase. Six types of student work artifacts were collected. Two of the artifact types represented work completed in five pairs and one triad, resulting in twelve artifacts for each of the types. Four of the artifact types reflected work completed in five groups of four and one group of five, resulting in six artifacts for each type. Thus, a total of 48 student work artifacts were collected throughout the duration of the study. Each artifact was evaluated with the same scoring criteria: (a) exceeds expectations, (b) meets expectations, (c) developing skills, and (d) needs improvement. Although results revealed a range of scores, none of the artifacts scored needs improvement. This section presents findings from the student work artifacts.

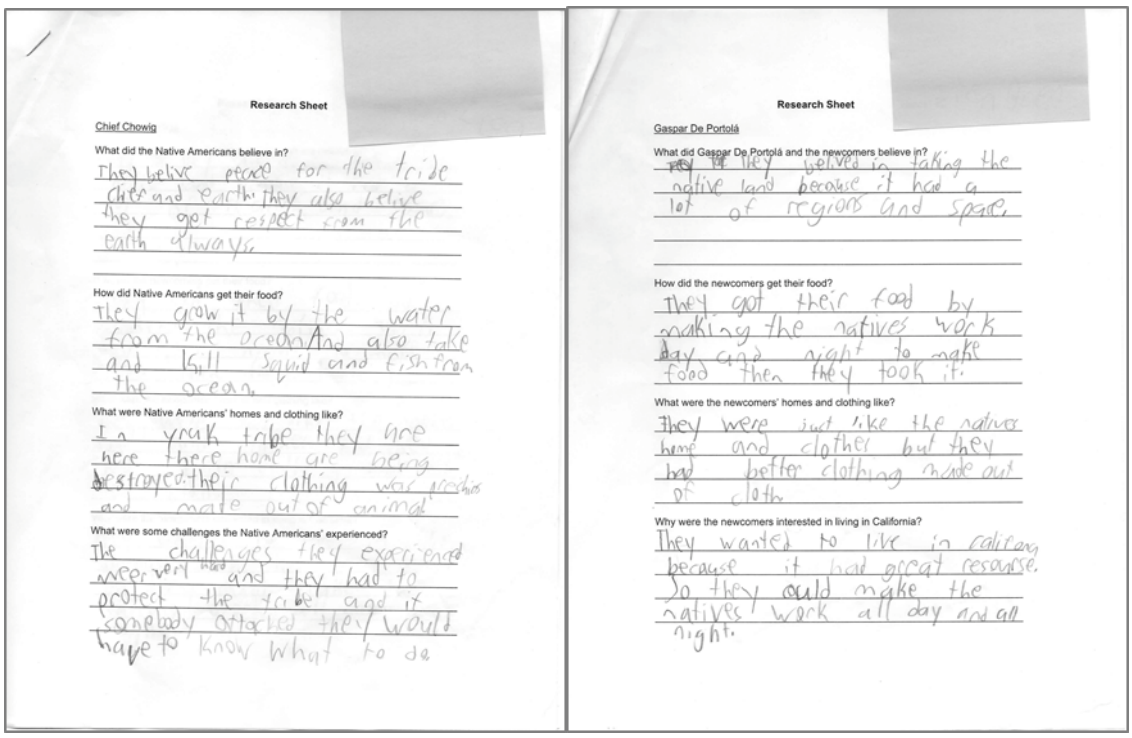
Student paired artifacts. The first two types of artifacts represent student work that was completed in the five pairs and one triad. These artifacts were collected from the first phase, Look, Listen, and Learn. Each pair of students completed the following artifacts: (a) research sheet, and (b) press conference sheet. The evaluation of artifacts completed in pairs is presented in Table 12.

Table 12

Student Artifacts from Pairs

Evaluation	Developing Skills	Meets Expectations	Exceeds Expectations
Research Sheet (*N* = 12)	25%	50%	25%
Press Conference Sheet (*N* = 12)	25%	58%	17%

Artifact Type: Research sheet. Since students completed the *research sheet* in pairs, there were a total of twelve artifacts (see Figure 4). There were six pairs and one group of three. The objective of this artifact was as follows: Demonstrate the ability to synthesize information from the role-play and biography sheets by taking notes during the activity. For this artifact, 50% (*n* = 6) of the pairs met expectations, while 25% (*n* = 3) exceeded expectations, and the remaining 25% (*n* = 3) demonstrated developing skills. A score of meets expectations displayed a complete research sheet. Questions were answered and the notes reflected the content and objective. Exceeds expectations had the same requirements, but the questions were more thoughtful and demonstrated thinking about the varying points of view. A developing skills score meant not every question was complete, answers were short, or answers did not always reflect the content.



Research Sheet

Chief Chowig

What did the Native Americans believe in?

They belive peace for the tribe Chief and earth they also belive they get respect from the earth always.

How did Native Americans get their food?

They grow it by the water from the creek And also take and kill squid and fish from the ocean.

What were Native Americans' homes and clothing like?

In yruk tribe they are here there home are being destroyed their clothing was from and made out of animal

What were some challenges the Native Americans' experienced?

The challenges they experienced were very hard and they had to protect the tribe and if somebody attacked they would have to know what to do

Research Sheet

Gaspar De Portolá

What did Gaspar De Portolá and the newcomers believe in?

They they believed in taking the native land because it had a lot of regions and space.

How did the newcomers get their food?

They got their food by making the natives work day and night to make food then they took it.

What were the newcomers' homes and clothing like?

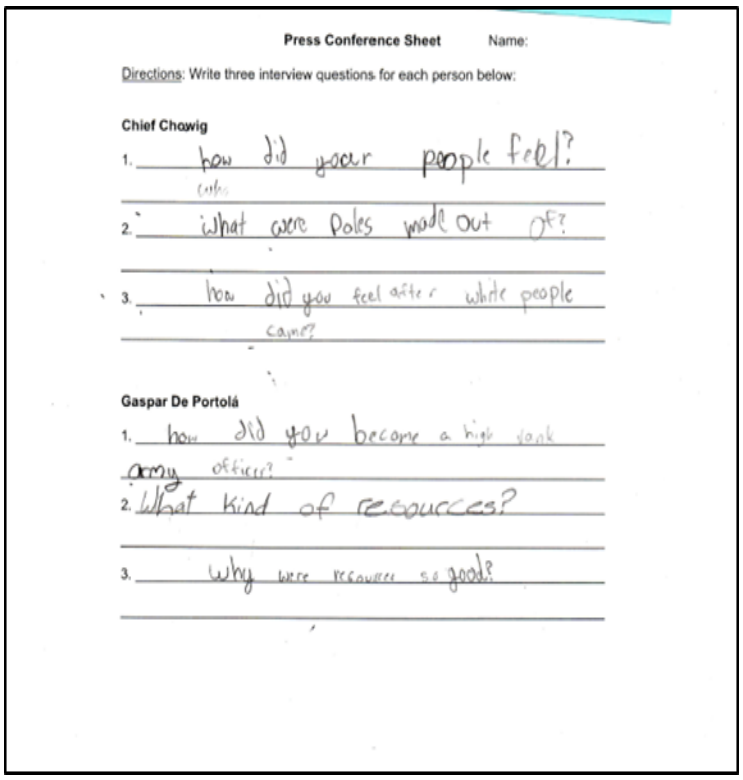
They were just like the natives home and clother but they had better clothing made out of cloth.

Why were the newcomers interested in living in California?

They wanted to live in californ because it had great resourse. So they ould make the natives work all day and all night.

Figure 4. Student work example of research sheet.

Artifact Type: Press conference sheet. There were also 12 artifacts for the press conference sheet (see Figure 5). One artifact was collected from each pair or triad. The objective of this artifact was as follows: Create thoughtful questions in an effort to understand each character's point of view and relationship/conflict with each other. For this artifact, a little more than half, 58% (n = 7), of the pairs met expectations. Two pairs, 17% (n = 2), exceeded expectations, and 25% (n = 3) were developing skills. A score of *meets expectations* required a list of questions that showed an effort to gain an understanding of the characters' points of view. *Exceeds expectations* required more insightful questions in an effort to understand the characters' points of view. *Developing skills* was scored when questions were general and focused on learning about the characters' personal lives rather than needs or point of view.



Press Conference Sheet Name:

Directions: Write three interview questions for each person below:

Chief Chowig

1. how did your people feel?
2. what were Poles made out of?
3. how did you feel after white people came?

Gaspar De Portolá

1. how did you become a high rank army officer?
2. What kind of resources?
3. why were resources so good?

Figure 5. Student work example of press conference sheet.

Student group artifacts. The remaining four types of artifacts represent work that was completed in groups of four or five. These artifacts were collected during four different phases of the design thinking challenge. Artifacts included: (a) press conference sheets: top four questions; (b) compare and contrast; (c) brainstorming board; and (d) map. The evaluation of the group artifacts is displayed in Table 13.

Table 13

Student Artifacts from Groups

Evaluation	Developing Skills	Meets Expectations	Exceeds Expectations
Top Four Press Conference Sheet ($N = 6$)	0%	67%	33%
Compare and Contrast ($N = 6$)	0%	100%	0%
Brainstorming Board ($N = 6$)	17%	50%	33%
Map ($N = 6$)	50%	33%	17%

Artifact Type: Top four questions for press conference. The top four questions for press conference artifacts were collected during the last activity in the first phase (see Figure 6). Each pair of students was assigned to join another pair, creating six groups (five groups of four and one group of five). The objective of this artifact was as follows: Narrow down the best four questions in order to understand each character's point of view and the relationship/conflict with each other. For this artifact, 67% (n = 4) of the groups met expectations and 33% (n = 2) of the groups exceeded expectations. In order to score meets expectations, the document required four questions that reflected an effort to understand the points of view. To score exceeds expectations, the four chosen questions reflected a more thoughtful effort to understand the varying points of view. Additionally, evidence of going beyond the expectations should have been observed. For example, since this document aided the press conference, the two groups receiving exceeds expectations wrote additional questions and notes.

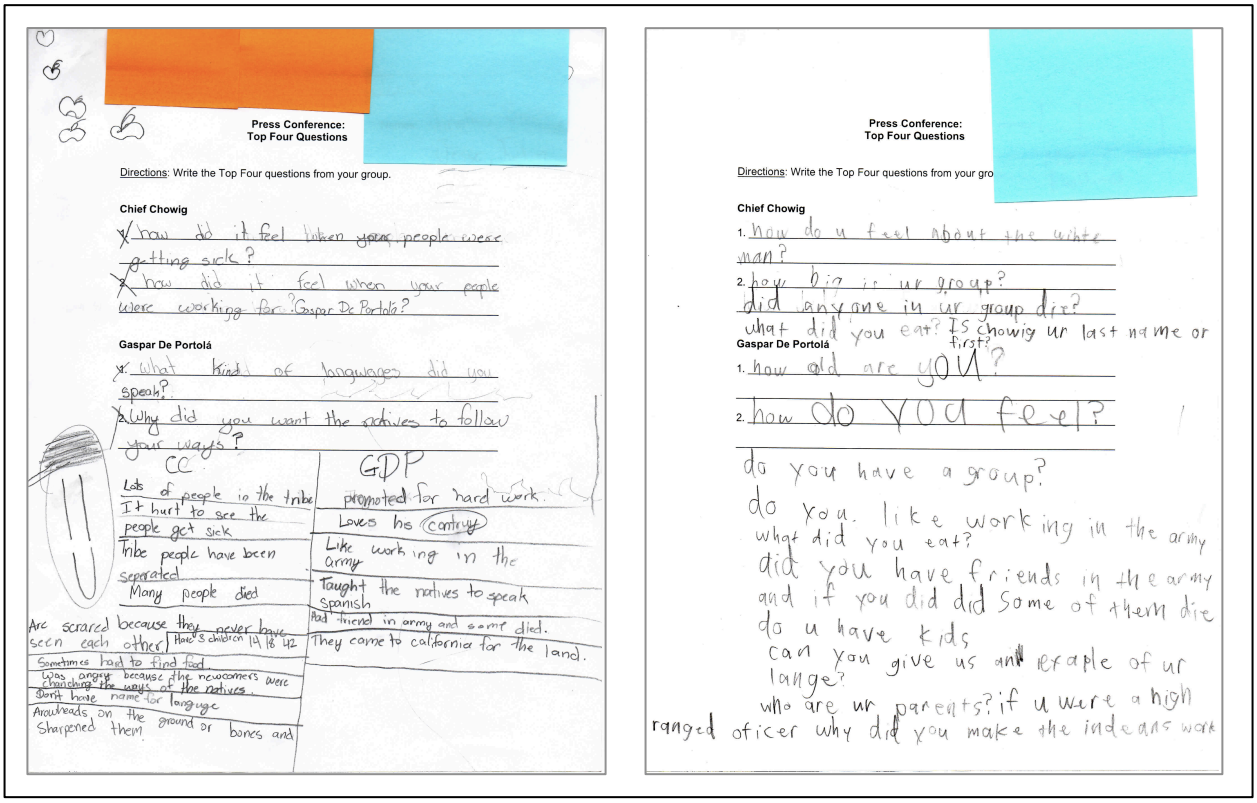


Figure 6. Student work examples of top four questions for press conference.

Artifact Type: Compare and contrast. The compare and contrast artifact consisted of a Venn Diagram that was completed during the Understand the Problem phase (see Figure 7). A total of six artifacts were collected, one from each group. The objective of this artifact was as follows: Complete a Venn Diagram comparing the needs of each character and their shared needs. The students first worked on Venn Diagram in groups, and then came together as a whole class to discuss. The teacher projected the same document on the board and called on students to share ideas. To make sure students had the right information to determine the problem, the students were instructed to modify their documents to mirror what the teacher wrote on the board. Thus, since students had modified their work to what the teacher presented, 100% ($N = 6$) of the groups achieved a score of meets expectations.

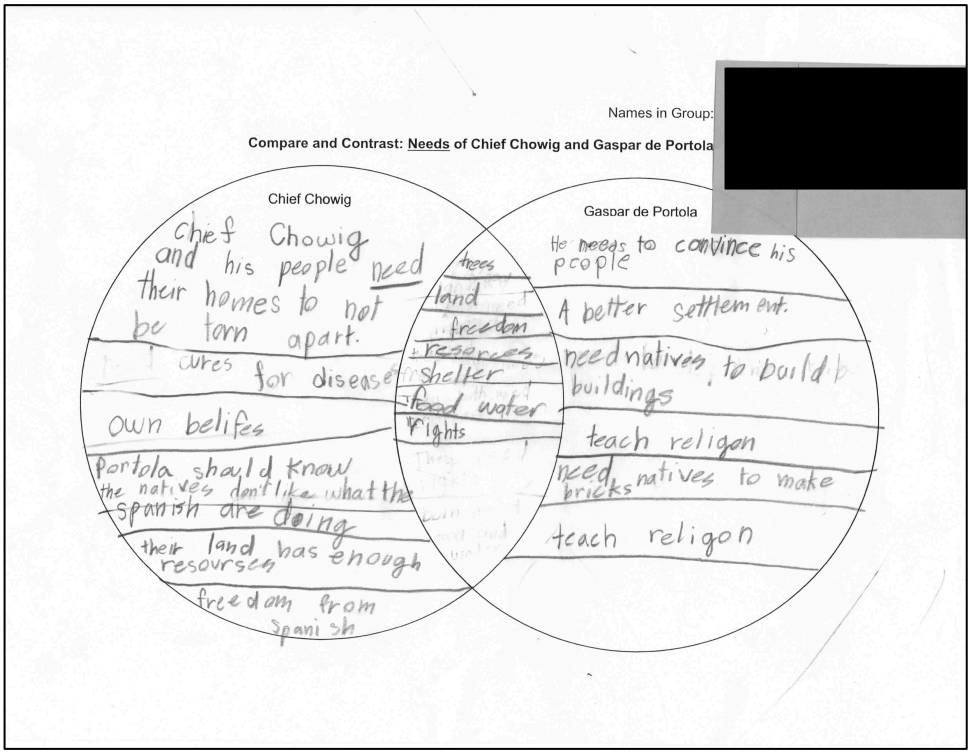


Figure 7. Student work example of compare and contrast.

Artifact Type: Brainstorming board. During the Navigate Ideas phase, students created a board of their brainstormed ideas (see Figure 8). These boards consisted of various sticky notes with ideas from members in the group. One artifact was collected from each group, totaling six artifacts. The objective of this artifact was as follows: Brainstorm several ideas about how the two characters can get along in a shared space. For this artifact, 50% (n = 3) of the groups met expectations, 33% (n = 2) exceeded expectations, and 17% (n = 1) were developing skills. To score meets expectations, the board required several brainstormed ideas. A score of exceeds expectations required several creative ideas on the board, represented in words, phrases, and drawings. Boards with only a few ideas received a score of developing skills.

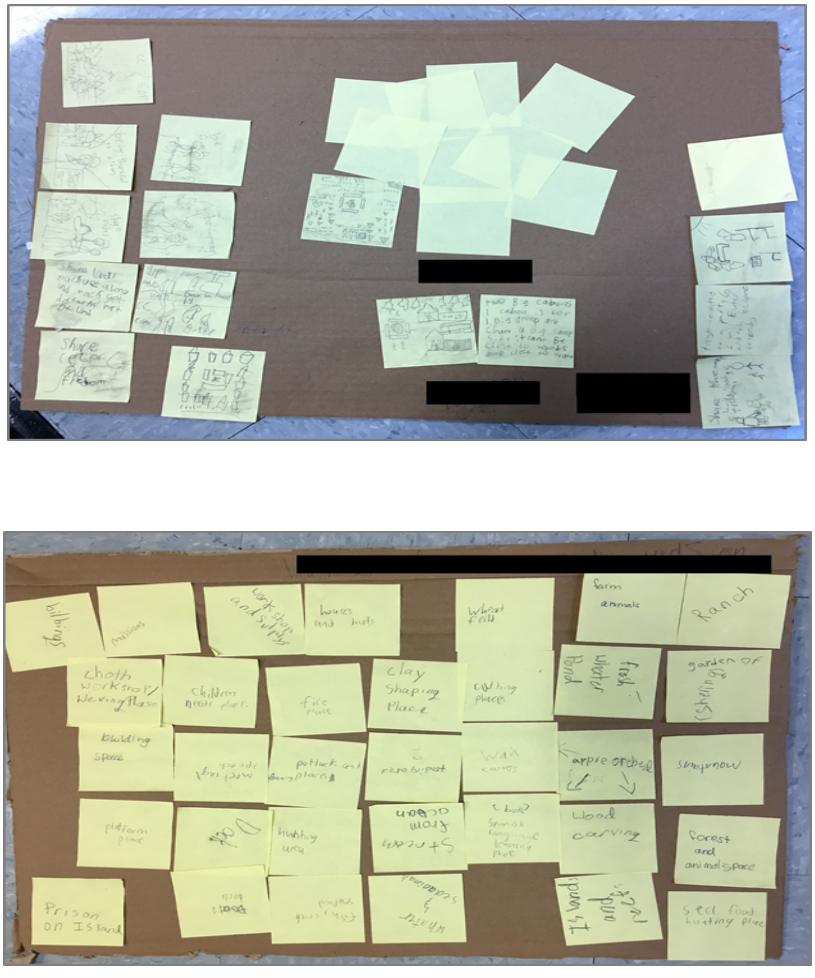


Figure 8. Student work examples of brainstorming board.

Artifact Type: Map. The last type of artifact was collected after the study was finished (see Figure 9). During the combined Create a Prototype and Highlight and Fix phase, students created maps, and then presented the maps during Launch. A total of six maps were collected, one from each group. The objective of this artifact was as follows: Using the brainstormed ideas, create a map showing how the characters share a space. The objective derived from the defined needs statement from a previous activity: Chief Chowig, a brave leader, and Gaspar de Portola, a religious man and leader, need to make a plan to share land and resources. As a result, 33% (n = 2) of the groups met expectations, 17% (n = 1) exceeded expectations, and 50% (n = 3) were developing skills. In order to score meets expectations, the map should have shown shared land reflecting the needs of Chief Chowig's people and Gaspar de Portola's people. To score exceeds expectations, the map needed to display creative ways to gather the groups together to help them get along. For example, the one group scoring exceeds expectations drew a campfire area in the middle so the two groups could come together and learn about each other. Maps that scored developing skills did not fully grasp the idea of a shared space. For this challenge, maps with this score succeeded in representing needs from both groups, but the land was divided in half and the groups did not live together.

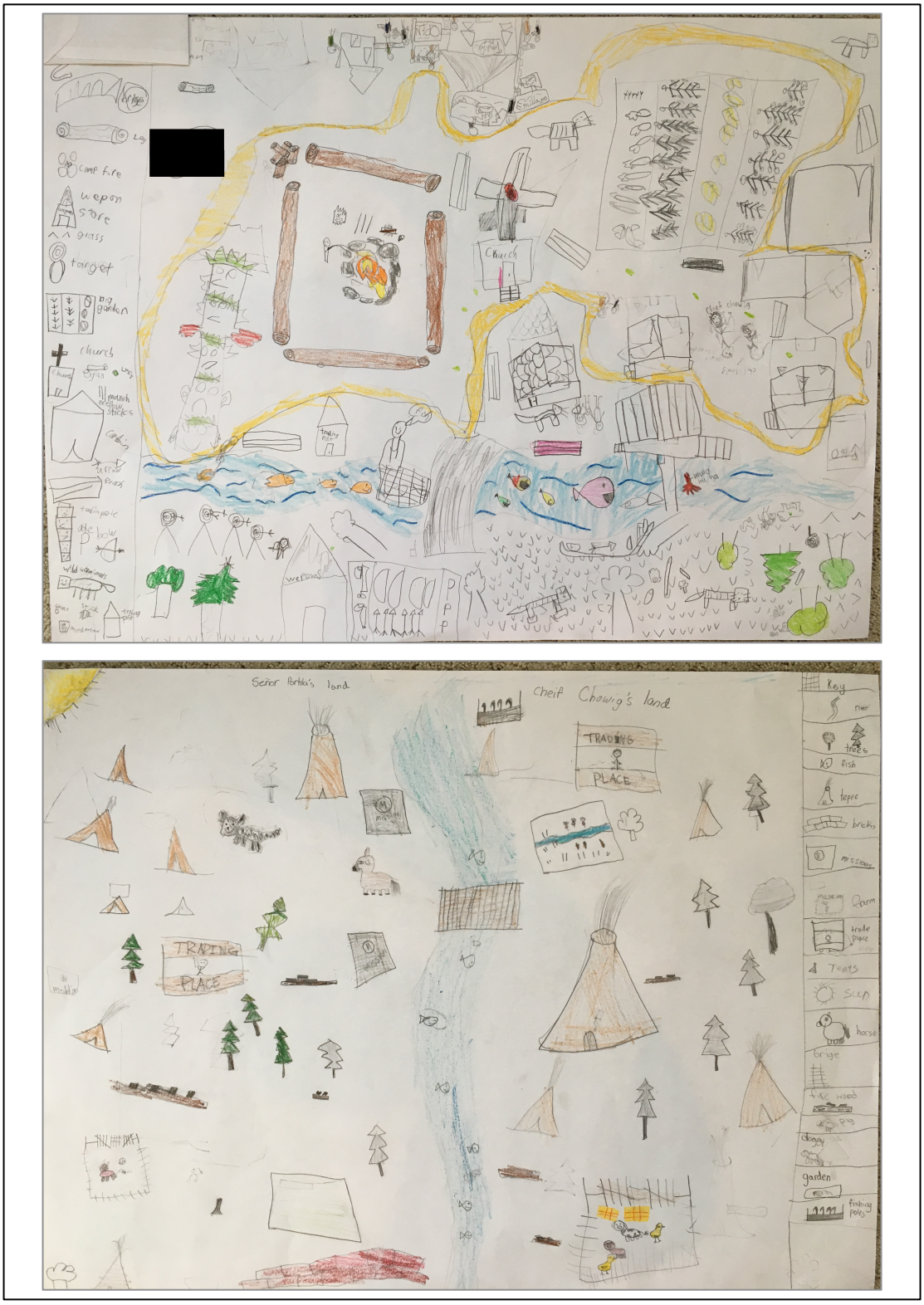


Figure 9. Student work examples of maps.

Teacher Interviews

Similar to student group interviews, the teacher completed an interview after every design thinking lesson. As a result, six interviews were conducted and analyzed. On average, the duration of interviews with the teacher ranged from six to ten minutes. Analysis of the interview data produced 102 coded responses relying on the same codebook that defined the skills: (a) collaboration, (b) communication, (c) creativity, (d) critical thinking, and (e) design thinking. Each skill and associated themes are presented in Table 14 with descriptions and supporting quotes from the teacher.

Table 14

Teacher Interview Findings

Skill	Themes
Collaboration (*N* = 24)	Collaborative Experiences (*n* = 3) Engagement (*n* = 18) Shared Responsibilities (*n* = 3)
Communication (*N* = 6)	Articulation of Ideas (*n* = 6)
Creativity (*N* = 18)	Idea Creation (*n* = 4) Iteration (*n* = 5) Risk Taking (*n* = 3) Sharing Ideas (*n* = 6)
Critical Thinking (*N* = 15)	Decision Making (*n* = 2) Drawing Conclusions (*n* = 7) Information Analysis (*n* = 2) Inquiry (*n* = 4)
Design Thinking (*N* = 39)	Teacher Design Thinking Practice (*n* = 16) Teacher Reflections on Design Thinking (*n* = 13) Teacher Reflections on Students (*n* = 10)

Skill One: Collaboration. Since students worked collaboratively during the challenge, numerous responses from the teacher indicated his observations about student collaboration. Of the 102 coded responses, 24 responses highlighted thoughts about collaboration. Within this skill, the analysis of the teacher interviews revealed three themes: (a) collaborative experiences, (b) engagement, and (c) shared responsibilities.

Collaborative experiences. During two interviews, the teacher described his insights into the students' collaborative experiences. His comments reported a positive collaborative experience amongst students. When asked to describe anything he noticed about the students during the first lesson, Look, Listen, and Learn, the teacher described the groups as working well together: "I thought for the most part when they worked in their groups they did a good job". Later, during the Understand the Problem interview, the teacher described how students were collaborating verbally and in writing within their groups: "Other groups were totally collaborative and all participating and sharing...not just the verbal contributions but also in the writing." During that same interview, the teacher reported collaboration in pairs, but also noticed some students taking charge: "There was collaboration in the pairs, but in the bigger groups there were some dominating personalities that were kinda telling people what to do."

Engagement. The teacher provided many responses about student engagement throughout interviews. Majority of the coded responses were in regards to engagement while working in groups, resulting in 18 of the 24 coded responses for collaboration. Some of the coded responses emphasized moments of whole group engagement, while other responses focused on individual student engagement. During different interviews, the teacher commented that all of the groups were engaged:

> They were engaged. They seemed interested from the beginning. Again, they were very engaged. They had a genuine interest in finding out more information. I would say that

> the majority of the groups, four students in each group, all of them were engaged, all seemed to be contributing.

During the last interview, the teacher proclaimed all of the students as engaged and on-task throughout each phase: “Well we talked about yesterday, we didn't have any groups that just sat there and didn't know what to do...in all phases of this.”

After the Understand the Problem phase, the teacher commented most of the groups were engaged, but required teacher facilitation:

> During the compare and contrast I would say most students were engaged. I saw some that quickly, maybe after about 2-3 minutes they let the group do all the work. I tried to get them re-engaged, physically moving students, asking questions, et cetera.

While most of the coded responses indicated positive participation and engagement from students, some of them identified lack of engagement within the groups. The teacher’s responses revealed sometimes one student in a group was not engaged:

> In the groups, in some of them, there was one person not as involved. They were playing with their pencil or not actively involved in the discussion. After about the first 5 minutes or so, after the redirect, there was maybe one student in two groups that kinda disengaged themselves. And I don't know that the students really knew how to bring those students back. They did for whatever reason became disengaged.

The teacher indicated mixed engagement when students came together with the whole class during the Understand the Problem phase:

> When we came back together as a group there were several students that were participating and sharing ideas. Others were what I call passengers on the bus, and same with the needs statement. We lost some students there. I'd say about 1/2 were engaged and 1/3 were actively engaged.

Alternatively, during the Ask Tons of Questions interview, the teacher acknowledged positive participation from a student who was not typically engaged: “There was one student in particular that is not typically engaged that was asking a lot of questions. They were pretty basic but the fact that he was asking questions showed me he was pretty interested in the activity.”

Shared responsibilities. A handful of the teacher's coded responses were comments about how the students shared responsibilities within their groups. Two comments from the interview after the combined Create a Prototype and Highlight and Fix phase indicated challenges in sharing responsibilities within the group. One comment described he only heard little discussion about how the groups decided to share tasks: "I heard a little discussion of 'I'll do this part and you do this part,' but um I don't know that that didn't go on but I didn't hear that."

Another response described the variety of ways students decided to share the task of presenting their maps for feedback from Chief Chowig and Gaspar de Portola. The teacher commented some groups were organized, whereas other groups did not plan how they would share the task of sharing their ideas:

> Some groups they were all just shouting things out. This is this. Um some groups were kinda organized in how they had laid out their space and organized in how they explained their different part. Other things were just kinda random, "there's a mission, there's a tree, there's an apple orchard," and not really explaining what the purpose was. The first group we talked with had a purpose for everything.

Skill Two: Communication. Some responses from the teacher interviews focused on student communication during the challenge. However, this skill only represented six of the 102 coded teacher responses. Although several themes emerged for the student responses, the coded teacher responses only resulted highlighted articulation of ideas.

Articulation of ideas. Some observations were made about the ability to express thoughts aloud. Most of the coded responses from the teacher occurred after the presentation, Launch phase, of the challenge. One response reported students were able to articulate the descriptive information on their map aloud to the class: "Yeah, I thought that several of the groups they said

what something was and they explained why it was there... it didn't really tie the cultures together, but they got that part of the directions."

A few coded responses indicated challenges in articulating ideas. The teacher commented one group did not share an important part of their maps with the class during the presentation:

> As I told them, in particular that one group that had the shared space and they had that campfire area and they had talked about sharing stories and getting to know each other...they totally left that out. I wasn't sure, thinking, oh maybe it's coming....

Another comment about the presentations indicated what was shared aloud depended on who presented it:

> The other thing was it kinda depended on who was presenting what. So the one group who had the church in the middle with the river running through the church, um Jasmine was the one who explained it and she was explaining it as two separate groups...this is there side and this is there side, where if Paul was presenting it he may have talked more about the shared space...so depending on who was presenting within the group maybe they weren't all of the same page maybe, but they're eight so...

During the Understand the Problem interview, the teacher identified some students as "passengers on the bus." When asked to elaborate why he thought some students did not participate, he revealed these students might have been uncomfortable with knowing how to answer questions aloud: "I would lean towards them being uncomfortable with knowing how to answer."

Skill Three: Creativity. The teacher shared several responses about creativity during the interviews. Comments associated with creativity accounted for 18 of the 102 teacher coded responses. Of those responses, four themes were recognized: (a) idea creation, (b) iteration, (c) risk taking, and (d) sharing ideas.

***Idea creation*.** The theme of idea creation surfaced during the Navigate Ideas phase of the challenge. The teacher provided a few comments on how students within their groups brainstormed ideas. One response indicated students were able to brainstorm several ideas for the

shared space: “Once they got the idea, they were able to brainstorm several different ideas for a shared space.”

Another comment highlighted the success of one group in regards to brainstorming:

> Yeah, one group in particular was truly brainstorming. They were splitballing different ideas and throwing anything out there. Theirs were short words or short phrases, while other groups were writing full sentences, but this one group in particular came up with about 30 different ideas...whatever was coming to their head...like what you are supposed to do in a brainstorm.

Last, the teacher shared how some groups experienced challenges brainstorming, as they did not focus on the physical plans tied to the layout:

> Other groups had a little bit more of a difficult time coming up with different ideas focusing more on a the physical plans, buildings, churches, walls, um whereas a few other groups were thinking about the nature, the rivers the lakes, the mountains.

Iteration. Students were asked to iterate on their ideas during the combined Create a Prototype and Highlight and Fix phase. During the interview, the teacher provided some insights into the students’ process of iteration. One comment revealed after receiving feedback, some groups began brainstorming right away, whereas other groups had difficulties getting started:

> I think that when we gave them feedback, they started brainstorming right away, they starting problem solving right away. Whereas other groups just sat and listened, and then they were prompted with what they needed to do because they looked a little dumbfounded at first.

Many of the comments about iteration were coded from the Launch phase, after witnessing how students modified their maps after receiving feedback. The teacher shared many groups did not iterate on the feedback:

> The other thing that was disappointing was that the groups who had their maps separate, and we pretty much explicitly told them they needed to get that together and come up with different ideas, I didn't see any changes. So that revision part of the cycle...I don't know what happened.

Later in the interview, the teacher further declared revision as a challenging concept for students to learn:

> Yeah and revision is hard for kids, it really is...in their writing it's hard for them to do revision, so it's almost more successful to do the same type of writing several times over a short period of time and give them feedback each time rather than giving them ongoing feedback on that single piece. It's hard...they don't want to do it again.

Risk taking. Comments associated with risk taking appeared in a few teacher responses during interviews. During the Navigate Ideas phase, the teacher shared students asked about a risky and original idea: "They even included a prison as part of their shared space and when they asked me about that I told them, 'Well, it's an idea. So we can talk about that.' Yeah so there was a lot of creativity." While reflecting during the last interview, the teacher expressed how students were willing to take risks: "Yeah and they were willing to take risks...they really were."

Sharing ideas. Six of the 18 coded responses for creativity were comments about the students' abilities to share ideas. Majority of those responses highlighted when the teacher noticed challenges in sharing ideas. During the Look, Listen, and Learn phase, the teacher explained he did not notice students sharing ideas, as the activity intended. Instead, students were focused on equally contributing to the questions rather than deducting the best questions:

> I don't know if there was that listening part and really taking to heart people's ideas. I also don't know if there was a lot of sharing of ideas. I don't know how much they owned their questions at this point. There weren't really any disagreements, which almost maybe you would want, but there didn't seem to be any of that. No one felt too strongly about anything...but then again it went back to that equality thing too.

Another comment revealed a challenge in sharing ideas collaboratively. During the Create a Prototype phase, the teacher commented some ideas may have been more independent, thus there was not much idea sharing:

> I think that some people did some things that were more independent. There were some strange things that showed up like haystacks and someone obviously had the idea of that.

> Someone had the idea of a prison so they put a prison on there. You can tell that was an individual idea rather than a group idea.

Conversely, some responses highlighted students' success in sharing ideas within their groups. During the Understand the Problem interview, the teacher described how students shared ideas verbally and in writing: "Other groups were totally collaborative and all participating and sharing...not just the verbal contributions but also in the writing. When we came back together as a group there were several students that were participating and sharing ideas."

Skill Four: Critical thinking. Several interviews revealed the teacher's observations about how students practiced critical thinking during activities. Comments associated with critical thinking accounted for 15 of the 102 coded teacher responses. Within those responses, four themes were present: (a) decision making, (b) drawing conclusions, (c) information analysis, and (d) inquiry.

***Decision-making*.** Two of the responses from the teacher interviews focused on the students' abilities to make decisions within their groups. As previously described, students were asked to narrow down to the top four questions within their groups during the Look, Listen, and Learn phase. The teacher commented on how students may have focused on being equal rather than deciding the top four

> I think that some of them were looking more at the equality of the questions that were going to be their top four interview questions because they were in pairs that came together, that they would choose two from one and two from the other. Soo maybe not choosing the best, but the best two from one group and the best two from the other.

Another comment described the variance in how students made decisions within their groups, noting that it was helpful when someone took the lead:

> So there were a couple groups that just got started right away and I think they had done some planning last week. They already had an idea of what their shared space was going to look like so they were able to get started right away. There were a couple groups that spent more time, not necessarily talking about what they were going to draw, but how

> they were going to write their names on the back of the paper. There were a couple groups where a couple people took charge and got them started right away and I think that was actually helpful because then the other kids kinda joined in. The groups that were y'know no one really took charge, they were a little more reluctant to get started.

Drawing conclusions. Some of the responses highlighted students' abilities to make inferences and draw conclusions during activities. During the Look, Listen, and Learn interview, the teacher reported students were able to make inferences for thick questions: "A couple students had trouble with what we call 'thick questions' the higher-level thinking questions, but they were able to make some inferences and come up with answers." Further in the interview, he elaborated:

> I thought one of the things they handled really well was the thick questions...that higher-level thinking questions. They did use their background knowledge. Had we not read that lesson yesterday we might not done as well...so if there's any other prep definitely let me know.

The teacher noted students were able to synthesize information and draw conclusions while working on the Venn Diagram: "They were able to synthesize things on the Venn Diagram and some of them had some really good ideas on the shared space."

During the last interview, the teacher reported a variance in how students drew conclusions. He explained some groups drew conclusions to create a shared space, while other groups kept the lands separate:

> Especially that first group that had the campfire. I mean to me, it was like okay, they got it...they got the overarching idea of that these people need to live together in peace and harmony, that they were different and they needed to learn about each other...whereas other groups chose, hey we are different so we are going to separate from each other.

Information analysis. The teacher provided two responses in regards to how students handled analyzing information. During the Understand the Problem interview, the teacher reported students successfully focused on analyzing the needs of the characters: "I think they

were well prepared to do a compare and contrast. One thing I was pleasantly surprised with is they did focus on needs and not traits."

During the Navigate Ideas interview, students were asked to analyze the information and brainstorm ideas. The teacher indicated students experienced difficulties with this task, until the redirection:

> At first they didn't seem to grasp what the objective was, they were more focused on the Venn Diagram and things they had already created before. But with redirection they understood that they needed to create a space and brainstorm ideas for a space for them to share. That was positive.

***Inquiry*.** Four of the 15 responses indicated the teacher's insights on the skill of asking questions during activities. Most coded responses were from the Ask Tons of Questions phase, where students participated in a press conference. The teacher expressed although questions were predetermined, students were inspired to generate additional questions during the press conference: "They had a genuine interest in finding out more information. They had their set questions they had come up with but those led to other questions that they thought of on the fly, which was really interested."

During the same phase, the teacher further described the students' questions to be higher-order thinking: "I think there was some critical thinking of some of the questions that were off-script. Some were some thick questions, higher-order thinking questions rather than basic questions."

During the last interview, the teacher described the inquiry process as successful: "I thought they did well with the process...I mean, coming up with the questions…they asked good questions."

Skill Five: Design thinking. Throughout interviews, the teacher provided insights into the process of facilitating design thinking activities. Responses focused on modifications made

by the teacher, thoughts on additional modifications, reflections on the design thinking process, and reflections on students during the process. Thirty-nine of the 102 teacher coded responses focused on design thinking. Themes for this skill included: (a) teacher design thinking practice, (b) teacher reflections on design thinking, and (c) teacher reflections on students.

Teacher design thinking practice. During interviews, 16 of the 39 coded responses revealed modifications the teacher made while implementing the activities. One of the teacher's comments described a modification during the press conference activity:

> It's funny because when we were talking about a press conference...talking about what it was, my thought first was that I would need to explain what a press conference was...and not even thinking about that I needed to explain what press was. So I'm glad I thought of thought because someone would've asked I'm sure. That's not a term they probably know.

A few times, the teacher explained the need to refocus students on the goal of the activity. During the Ask Tons of Questions phase, the teacher shared:

> I think again making sure that they understand they need to focus on the conflict between the two characters. I tried to bring that in.

> At one point I decided to make sure they understood that even though I was saying things that the Spaniards wanted, it wasn't necessarily what the natives wanted. That I was clear...that there was conflict between us. The idea that the Spanish were probably thinking they were doing a noble thing when in actuality it's not what the natives wanted. I wanted to make sure that as clear to them. Instead of asking like, do they have a wife and kid, etc.

Another redirection occurred during the Navigate Ideas phase, when the teacher noticed the students did not understand the objective of the task:

> After the redirection, it became clear that to get what we want we would need to do a map, and not leave it open-ended on how they would create the shared space. I think they get the gist of what they're supposed to do.

Several coded passages also highlighted the teacher's thoughts on how he would facilitate a certain design thinking activity differently. During the Navigate Ideas phase, the teacher indicated a need to explain and model the task more clearly:

> Yeah, and I think at the beginning of the lesson I spent more time modeling what brainstorming might look like, rather than what the task was...I didn't really model the task so that's why I needed to do that redirect, but I think they got it.

During the same phase, the teacher shared he should have explained the revision process more clearly as "…there isn't a wrong answer, since some students were not sure how to proceed with the feedback." When asked how he thought the students performed during presentations, the teacher expressed disappointment. Some coded responses indicated the need for more modeling:

> Um poorly…I think that on my part, I should have done a little more modeling for them of what I expected.

> I think I didn't emphasize the culture part of it...so in hindsight I would've done that...and I think that too, time wise, I probably would've modeled it a little more for them.

The teacher also expressed the need to talk to his students about presentation skills:

> I do want to talk to them about...like not standing in front of the poster so people can see, that's not good. Having a clear idea of a start, beginning, and end, although I did notice Jasmine said, 'and the last thing...' that was good.

Teacher reflections on design thinking. Reflections on the design thinking process occurred throughout interviews, resulting in 13 of the 39 coded passages. Passages included reflections on ideas, such as: when to share the steps in the design thinking framework with students, optimal grouping for lower grades, time constraints of activities, and the value of design thinking in classrooms. During the Look, Listen, and Learn interview, the researcher asked the teacher's thoughts on the value of explaining the steps in the LAUNCH Cycle before conducting a design thinking challenge. The teacher initially responded with mixed feelings: "Um, yeah I think that's fine…I don't think things have to be a secret. But I don't know that students are always interested...basically what we did is sort of a jigsaw but I never call it that."

Later in the interview, the teacher confirmed he did not think it was necessary: “I didn't think it was necessary to do that. I'm trying to think if I normally do that...you know, I do think I tell them the process, but I didn't feel like that was necessary this.”

After the final phase, the researcher followed-up by asking the teacher if he thought it was still the right decision to not share the steps at the beginning of the challenge. The teacher responded:

> I think so. I think that at this age, I think it's more interesting for teachers and adults to see that process than for the kid...they are looking at it like, oh neat rocket ship, but some of it were right on…they knew exactly what we had done at each step of the way. Had we done it at the beginning without them having done anything, I think it just would've been right over their heads.

During the same interview, the teacher also provided some general reflections on what worked for the lower grade in regards to how students were grouped:

> So with the lower grades, I think it was wise to be strategic on how the groups were formed. I also think that the group of four was an optimal number. We had one group of 5 and it was fine, but when the groups get bigger people get excluded. So I think that was also important in forming the groups.

He continued by sharing reflections on parameters we set in order to facilitate a design thinking challenge within a lower grade level:

> I think that what we did was good because I think we kept it pretty open-ended and then evaluated if we needed to give more direction, and I think that if you were dealing with upper-grade kids you could make it more open-ended and kinda force them to figure some things out. Whereas with the younger kids I think you have to monitor closely to see...sometimes it's just a small little prompt they need, scaffolding, to help them go in the right direction.

A few of the coded passages indicated time constraints of design thinking activities. Although time is expressed as an issue, the teacher described the design thinking activities as being worthwhile:

> Um, well I guess when you're wanting to do projects like this the biggest challenge like this is time, and there's so much we need to cover so sometimes projects like these, "like

> ahh can I really afford the time to do it?" but they are worthwhile and I think the more you do them the less time they would actually take.

Also during the last interview, the researcher asked if the teacher recognized benefits to implementing a design thinking activity in the classroom and if he would want to do it again. The teacher responded positively and described design thinking as a powerful methodology:

> Yes, absolutely. And I think too, you can read things in books um, but that experience, the kinetic and talk, even just the opportunity they had to talk about it, not just write about it, to talk about it I thought was very powerful.

Teacher reflections on students. Ten of the 39 responses indicated the teacher's reflections on students. Comments described students as risk takers and leaders. During the Understand the Process interview, the teacher identified students as risk takers: "I'm excited because I think this group for the most part are risk takers and willing to take a chance to try something."

A few of the coded responses indicated leaders within the groups. During the Look, Listen, and Learn phase, the teacher shared:

> I saw some groups where there was a definite leader that was the driving force. There were a couple groups where a couple people took charge and got them started right away and I think that was actually helpful because then the other kids kinda joined in.

This idea was extended further when the teacher described another leader during the press conference: "One group in particular someone was asking a lot of questions so it looked like maybe she was delegating once I commented on that."

One of the teacher's comments presented the idea that the concept may have been too advanced for students. During the last interview, the teacher posed a question about the maturity of students by saying, Was this concept maybe a little too big for them? The researcher asked him to clarify if he considered the chosen topic or the design thinking process as too big, and if he thought is would work. The teacher clarified: "Yeah I definitely think it would work. I

thought they did well with the process." Further, he explained: "…but I think they just lacked the maturity to get what we had as an objective."

Teacher Pre-Post Self-Reflections

The teacher was asked to reflect on two questions before and after the study. The questions were aimed to gauge the teacher's experience with the theoretical frameworks for this study: 21st century learning and design thinking. The teacher provided handwritten responses to the questions.

The first question asked, How would you currently define 21st century learning? The teacher's response to this question prior to the study included five bullet points consisting of concepts such as, "open-ended questions, learning through discovery, including technology, solving problems in multiple ways, and collaborative work." After the study, the teacher's response to this question was more reflective with the addition of concepts, such as curriculum, creative thinkers, and a real world connection. In the post self-reflection, he described 21st century learning as "…a combination of student centered and curriculum/standards based learning." Further, the teacher explained students are "…expected to be critical and creative thinkers." Then, he elaborated on connections to the real world by writing: A 21st century learner must be able to analyze and solve problems in a world that is constantly changing. They must not only be competent in factual knowledge, but proficient in technology, listening, and speaking.

The second question was, How would you currently define design thinking? Prior to the study, the teacher responded with, "Not sure." After the study, the teacher provided a thorough answer explaining his new understanding of design thinking. Not only did his explanation reflect the steps implemented during the study, it highlighted the skills students practice during design thinking:

> In our design thinking process, the students were posed a problem. Then they gathered information about the problem. Next they made a prototype of a solution to the problem. They then received feedback for their prototype and used that information to make changes and improvements. Finally they presented their product. So they analyzed a problem, gathered information by brainstorming questions, made a prototype, gathered feedback and edited, and presented.

Researcher Observations and Reflections

The researcher recorded observations and reflections in her field notes throughout the study. The field notes were analyzed using the same process and codebook as the narrative data from the teacher and students. While notes were coded for every skill category, majority of the researcher's notes highlighted skills in design thinking and communication.

The researcher wrote several notes about the teacher's design thinking practice. Most of the researcher's notes indicated a modification the teacher made during a lesson activity. For example, observations highlighted when the teacher decided to explain a concept a little more thoroughly, such as defining a press conference, explaining how to brainstorm, or redirecting students during the brainstorm. The teacher most often provided examples when explaining the concepts. During a few of the lessons, the researcher described how the teacher asked if it was okay to make modifications. In response, the researcher encouraged the teacher to incorporate modifications or teaching best practices as often as he felt was necessary.

Additional observations about the teacher's design thinking practice were from examples when the teacher added criteria to the lesson. Examples include providing sentence starters for the press conference activity, assigning a note taker, prompting students to start with, "This question is for…" during the press conference, or adding guidelines for the presentations. Another note revealed some insight into the teacher's thought process during the brainstorming activity. The teacher shared with the researcher that it would be ideal to provide some parameters

for the upcoming prototyping phase. Further, the teacher explained leaving the prototype too open-ended for this grade level might be too challenging.

The researcher made many reflections about the teacher's design thinking practice while observing the lessons. First, the researcher noted how the teacher facilitated the definition of the needs statement. The researcher noticed the teacher had to step students through small tasks, posed as questions, in order to create a needs statement. It was clear that writing a needs statement on their own would have been challenging for students. Another reflection described the challenges students experienced during the combined Create a Prototype and Highlight and Fix phase. The researcher commented students would have benefited from having a class discussion to learn more about the iteration process. More time to iterate on maps would have also been beneficial for students. The same two comments were also shared as enhancements for the presentations.

The next most recognized skill was communication. In particular, all of the highlighted communication skills focused on students' articulation of ideas. The researcher noticed students articulating ideas aloud during three different activities. First, during the whole class Venn Diagram activity, students communicated the needs for Chief Chowig and Gaspar de Portola in response to questions posed by the teacher. Next, the researcher wrote several comments about students expressing ideas aloud when presenting the prototypes for feedback. Students explained what they drew on their maps and why they placed it in the location. Last, the researcher observed students articulating ideas during the presentations by sharing the details of their maps aloud to the class.

The skill with the next largest number of codes was critical thinking. The researcher observed information analysis on several occasions. Most notably, students analyzed information

from the debate and biography sheets, then during the discussion with the whole class. The researcher observed inquiry during the press conference, when students posed questions to Chief Chowig and Gaspar de Portola. The researcher commented that students were so excited to ask questions they even started to think of new questions in the middle of the activity. Thus, the researcher reflected that the press conference could have continued for much longer than allotted. Observations highlighted students drawing conclusions when they responded to questions posed by the teacher throughout the activities. Also decision-making appeared twice as the researcher observed students using "Rock, Paper, Scissors" as a method for problem solving on different occasions.

For creativity, many observations were made about sharing ideas and iteration. The researcher noticed students sharing ideas in their groups during activities, such as determining which questions to ask Chief Chowig and Gaspar de Portola. The researcher also noted students struggled with sharing their ideas at the beginning of the brainstorming activity. However, students successfully shared ideas and brainstormed after a redirection presented by the teacher. Several comments were made about iteration. While receiving feedback during the Highlight and Fix phase, the researcher described how students shared new ideas for modifications during the feedback session. Further, students were already planning how to make changes and were asking for feedback on their proposed ideas. However, the researcher commented many students seemed nervous and uncomfortable while receiving feedback. Students acted as if they were not doing the activity correctly or may be in trouble. Thus, the researcher reflected the feedback and revision process might have been new for students. The researcher also noted some iteration during the presentations. For example, one group added a bridge to the river to allow Chief Chowig and Gaspar de Portola to share land and resources.

Engagement and shared responsibility were the skills recognized for collaboration. Observations about student engagement appeared throughout all of the lessons. The researcher described the students as excited and cheering when they saw the researcher enter the room, since they knew it was time to continue the design thinking challenge. Most comments about student engagement focused on students working well together. Although the researcher noted the noise level was higher than typical classroom activities, students were observed to be on-task and working towards the lesson objectives. This was especially relevant while students worked on the prototypes. If a student was off-task, the researcher observed the teacher re-engaging the student. The researcher noticed students sharing responsibilities by taking turns during the feedback sessions and presentations. Before the presentations students prepared in their groups by discussing who was going to share different parts of the map. Students were standing, practicing in their groups, and giving each other feedback. During the presentation, the researcher wrote several comments about students taking turns in their groups while sharing their maps with the class.

Chapter Five: Research Study Conclusions, Implications, and Recommendations for Practice and Future Research

This chapter discusses what was learned from this exploratory case study about implementing a design thinking process as an instructional methodology in an elementary school classroom and the impact on 21st century skills. For the purpose of this study, 21st century skills were characterized as the Four Cs: communication, critical thinking, creativity, and collaboration (Partnership for 21st Century Learning, 2015). A brief description of the significance of the study is defined, along with a discussion of key findings, research study conclusions, future recommendations, and limitations and validity of the study.

Background and Significance

Coined as a term to define skills necessary for a successful 21st century workforce, 21st century skills has long been discussed and debated in education. "The ability to quickly acquire and apply new knowledge and the know-how to apply essential 21st century skills—problem solving, communication, teamwork, technology use, innovation" (Trilling & Fadel, 2009, p. 11) are argued as some of the skills necessary for a shifting workforce. For the past decade, the education industry has strived to define 21st century learning in classrooms. Many practitioners turn to organizations that have designed frameworks for 21st century learning, such as the Partnership for 21st Century Learning.

While organizations have created conceptual resources such as frameworks and taxonomies, these resources do not support practical implementation. Research has suggested instructional frameworks with roots in constructivism to be an effective way to cultivate 21st century skills (Kent & McNergney, 1999; Noweski et al., 2012; Scheer et al., 2012). Literature presents project-based learning, problem-based learning, and design-based learning as

constructivist instructional strategies for 21st century learning (Barrows, 1985; Kolodner et al., 2003; Pacific Policy Research Center, 2010; Prince, 2004; Rotherham & Willingham, 2009; Sawyer, 2005; Snape & Fox-Turnbull, 2011; Thomas, 2000).

With a recent emergence of design studies in education, design-based strategies are understudied. However, researchers claim the design strategy, design thinking, can help develop a mindset and the skills in demand of the 21st century (Noweski et al., 2012; Scheer et al., 2012). While research presents design thinking as an effective instructional strategy for 21st century skill development (Noweski et al., 2012; Scheer et al., 2012), it is most commonly linked to STEAM initiatives in middle or high school contexts (Berland et al., 2013; Bowler, 2014; Casey et al., 2011; Jarrett, 2016; Rice, 2011). Current research and examples are minimal for elementary contexts and cross-disciplinary contexts. Additionally, while design thinking frameworks are accessible to educators, suggestions for classroom implementation are limited (Kimbell, 2011; Lahey, 2017), particularly when integrated into classroom curriculum.

The goal of this study was to contribute to educators' understanding of design thinking as an instructional strategy by offering a case study example. Results may also inform practices for professional learning about design thinking in schools. The term professional learning is used purposefully as this trend is replacing professional development in schools. Teachers are encouraged, and sometimes required, to continually evolve their teaching practices. The study reveals practical knowledge for implementing design thinking into an existing curriculum in any discipline. The practical knowledge may inform both classroom teachers and professional learning programs. The case study is particularly meaningful for lower elementary classrooms. Additionally, results provide guidance for 21st century skill development, adding to the literature on 21st century skills.

Conceptual frameworks. This study was built upon the conceptual frameworks of 21st century skills, particularly the Four Cs, and design thinking. Each framework is briefly discussed in this section.

21st century learning. As the United States economy has shifted from the Industrial Age to the Knowledge Age (Trilling & Fadel, 2009), so have the workplace skills required to meet the demands. The Industrial Age focused on mass production and manufacturing for natural resources, whereas the Knowledge Age hones in on intellectual capabilities, knowledge, and innovation such as information and communication technologies (Bereiter, 2002; Powell & Snellman, 2004; Trilling & Fadel, 2009). As a result of this shift, developed countries require people to achieve more creative jobs such as work in research, global supply chain management, design, development, marketing, and sales, (National Center on Education and the Economy, 2007).

Attached to the Knowledge Age is a skillset most commonly defined as 21st century skills. These skills are identified as important for individuals to be successful in jobs of the 21st century. As public schools, national education groups, higher education organizations, and workforce development groups recognize 21st century skills as crucial for students to learn (Silva, 2009); organizations have produced frameworks to define 21st century skills. Frameworks include, but are not limited to the enGauge framework (Metiri Group & NCREL, 2003), the LEAP framework (NEA, 2012), Framework for 21st Century Curriculum and Assessment (NCTE, 2013), and the Partnership for 21st Century Learning Framework (Partnership for 21st Century Learning, 2015). Among these frameworks, the Partnership for 21st Century Learning is most widely used in education as it offers several ancillary publications that go into detail about 21st century skills (Dede, 2009). The Partnership for 21st Century Learning (2015) presents four

skill categories in their framework: (a) life and career skills, (b) learning and innovation skills, (c) key subjects, and information, (d) media and technology skills. However, many practitioners associate Learning and Innovation Skills, also known as the Four Cs: critical thinking, communication, collaboration, and creativity, with 21st century learning.

Design thinking. As "…a human-centered, creative, iterative, and practical approach to finding the best ideas and ultimate solutions" (Brown, 2008, p. 92), design thinking is traditionally practiced in engineering and design fields as a method for solving complex problems. Industry experts define design thinking as a cognitive process and mindset (Luka, 2014). Solving ill-defined, complex problems by way of design thinking became more common in other industries, such as business (Dorst, 2011; Dunne & Martin, 2006; Martin, 2009), healthcare (Bate & Robert, 2007; Johnson et al., 2016; McCreary, 2010), and more recently education (Goldman et al, 2014; Noweski et al., 2012; Razzouk & Shute, 2012).

When employed as an instructional strategy, literature reveals design thinking can practice constructivist methodology (Noweski et al., 2012; Scheer et al., 2012). It is best known to support STEAM and Makerspace initiatives (Berland et al., 2013; Bowler, 2014; Casey et al., 2011; Jarrett, 2016; Rice, 2011). However, educationalists claim design thinking can be applied to any discipline (Gardner, 2009; Pink, 2010), and can help students practice 21st century skills, such as collaboration (Kangas et al., 2013; Kolodner et al., 2003), creativity (Barlex & Trebell, 2008; Gerber & Carroll, 2012), and higher-order thinking (Schooler, 2004).

Several design organizations have created guides for implementing design thinking in classrooms. For example, in 2012, the design firm IDEO published *Design Thinking for Educators*, and Stanford University's d.school, REDlab, and K-12 Lab Network, provide insight, resources, and examples for educators. There are also design thinking frameworks specific to

educational contexts, such as Spencer and Juliani's (2016) LAUNCH Cycle which adapts the design thinking process for K-12 contexts with students. Each guide presents steps or phases for educators to implement the design thinking process. For example, the LAUNCH Cycle (Spencer & Juliani, 2016) consists of the following phases: (a) look, listen, and learn; (b) ask lots of questions; (c) understand the process or problem; (d) navigate ideas; (e) create a prototype; (f) highlight and fix; then (g) launch to an audience.

Methods. An exploratory instrumental case study was conducted to gain insights into the students' and teacher's design thinking experiences in the context of a classroom. A third grade classroom, consisting of 25 students and one teacher participated in the study during the fall of 2018. From pre-study preparation with the teacher to the last lesson implementation, the study occurred over a period of three months. The researcher partnered with the teacher to design the lessons framed around the K-12 adapted design thinking LAUNCH Cycle (Spencer & Juliani, 2016). While design thinking, and the LAUNCH Cycle in this case, was the instructional approach for the lessons, the content focused on California third grade social studies curriculum. The teacher conducted the design thinking lessons once a week over a period of seven weeks.

As case study literature emphasizes the value of multiple data sources, the researcher collected a variety of data from students and the teacher. Pre-post study data were collected for comparative analysis. The researcher collected pre-and post- study self-assessments from the students and pre- and post- self-reflections from the students and the teacher. Researcher observations about the students and lesson activities were also made during lessons. Interviews were conducted for student groups and the teacher after each design thinking lesson. Additionally, artifacts including photographs and student work samples were collected throughout the study. Narrative data from the interviews and self-reflections were analyzed in the

HyperRESEARCH qualitative software program. Descriptive analytics were used to analyze quantitative data.

Discussion of Key Findings

Analysis of the interview findings, student self-assessments, student artifacts, and teacher self-reflections resulted in key findings that contribute to understanding the process and outcomes of implementing a design thinking process into learning activities within an existing curriculum for students in elementary school classrooms. The partnership with the teacher lead to findings related to the teacher's thought process while implementing design thinking as an instructional strategy. The student responses provided rich data about their perceived skill developments and experiences with design thinking. The key findings are discussed in response to the research sub-questions that framed this study.

What does it look like for students to engage in design thinking learning activities in the classroom? With facilitation from the teacher, students collaboratively engaged in a series of learning activities to design a solution for a problem. Teacher interviews and researcher field notes revealed the teacher closely facilitated the design thinking phases. While introducing a new design thinking phase, the teacher often made modifications to the lesson plan to further explain relevant concepts or provide examples. The teacher explained curricular concepts as well as design thinking concepts for students, such as sharing ideas or brainstorming. These concepts were often supported with examples to reinforce learning. During interviews, the teacher described a certain mindset is required for design thinking in lower grades. He suggested keeping activities open-ended, but monitoring closely in case students require a small prompt or scaffolding to help them move in the desired direction. An additional consideration for lower grades was to form smaller groups, such as groups of four students.

Findings from the teacher and researcher described students as working collaboratively throughout the design thinking phases. In fact, the researcher described the classroom setting as an above average noise level while students were working together on activities. Students were engaged and on-task as they worked on the objective associated with each phase. They practiced skills such as analyzing information, drawing conclusions, asking questions, brainstorming, ideating, iterating, and articulating ideas. While there was a variance in how students exercised these skills, everything was accomplished collaboratively.

How do students perceive design thinking learning activities? Findings from this study reveal students had an overall positive perception of the design thinking experience. Both teacher and student interviews showed engagement and excitement from students during design thinking phases. The researcher's notes support this notion by describing how students were excited to begin each design thinking lesson. One reason students may have enjoyed design thinking is because it was different from their typical classroom experience. During interviews, some students described design thinking as a different type of learning experience and appreciated the opportunity to bring their ideas to life. As a result, students wished they could participant in more design thinking. From the self-reflection, majority of students declared the willingness to participate in another design thinking challenge in the future.

While there was a general positive perception to the design thinking experience, findings illustrate aspects of the process that were favored and some that were challenging. When asked about their favorite phase, majority of students described prototyping or presenting as their favorite. More than 75% of the students also described the Create a Prototype phase as a creative risk. Therefore, findings suggest students enjoyed working on creative challenges within their groups.

Another student perception of design thinking focused on the collaborative nature of the activities. Majority of the findings about collaboration were positive and most students perceived their groups as working well together. In fact, several students shared they learned how to work collaboratively as a result of the design thinking experience. Students also recognized collaboration could help them achieve outcomes they may have not been able to on their own. While most of the comments were positive, some students regarded collaboration as challenging. Students shared several challenges with making decisions within their groups. Majority of the challenges resulted from the Understand the Problem phase when students worked on a Venn Diagram to define the needs of the characters. Challenges were also identified for communication skills, such as presenting the maps to the class. Several students expressed articulating ideas aloud to the class as challenging. However, although possibly challenging, some students enjoyed presenting to their classmates and described it as a creative risk.

Do students demonstrate critical thinking, communication, collaboration, and creativity skills while participating in design thinking learning activities? If so, how? Findings suggest that students practice critical thinking, communication, collaboration, and creativity skills as a result of working through the objectives required for each design thinking phase. While most of the data highlighted students strengthening the skills, some challenges were also identified. However, regardless of a success or a challenge, students were presented with opportunities to practice these skills.

Out of all the passages from the interviews, self-reflections, and field notes, collaboration had the highest number of coded passages. Students showed engagement in collaborative activities throughout the process. Sometimes lack of participation from a student in the group was identified. Students also practiced sharing responsibilities and making decisions in groups.

Creativity had the second highest number of coded passages out of the narrative data. Students shared ideas verbally and in writing, brainstormed, took risks, and were challenged to learn from failure. The skill group with the third highest number of coded passages was critical thinking. Students analyzed information, practiced making inferences, generated thoughtful questions, and drew conclusions. The skill group with the least amount of coded passages was communication. Although student and teacher data revealed challenges with articulating ideas, the researcher noticed students practicing this skill successfully throughout various activities.

Findings from students' self-assessment also indicate an improvement in the development of the Four Cs skills. Overall, students perceived growth in the development of their Four Cs skills after completing the design thinking challenge. Out of all the skills, collaboration showed the most growth from pre to post assessment. Additionally, collaboration had the lowest percentages for students claiming they had not yet acquired the skill after the challenge. All of the skills related to the additional Four Cs categories showed growth, except for one skill in creativity about being open to new ideas. However, the number of students reporting Not Yet for that skill remained the same from pre to post assessment.

How does the involved educator believe the use of design thinking contributes to the acquisition of critical thinking, communication, collaboration, and creativity in an elementary school classroom? Connections between design thinking and the Four Cs were relevant throughout the teacher data. In his post-self-reflection, the teacher connected several skills within the Four Cs framework to the design thinking process. The teacher explained in design thinking, students, "analyzed a problem, gathered information by brainstorming questions, made a prototype, gathered feedback and edited, and presented." The described skills match the researcher's codebook on what was defined for the skill groups relating to the Four Cs.

For example, analyzed a problem accounts for information analysis, which was listed in the critical thinking skill group. Next, brainstorming questions, made a prototype accounts for brainstorming and prototyping in the creativity skill group. Then, presented accounts for presentations in the communication skill group. While there were several other sub-skills for each category, all of these skills were practiced collaboratively. Therefore, the teacher connected the Four Cs to design thinking through his description. Also in the post self-reflection, the teacher described the real world connections required for 21st century learning. Not only did the teacher recognize how design thinking could contribute to the Four Cs, but he also had a better understanding how it could help real-world problem solving necessary for the 21st century.

Throughout interviews, the teacher identified several instances students practiced the Four Cs. About 24% of his comments were about collaboration, which contained the highest number of coded passages out of all the skills from the teacher data. For collaboration, his comments reported an overall positive collaborative experience amongst students. Students were recognized as collaborating verbally and in writing within their groups. Challenges during collaboration were also shared. Students struggled with sharing responsibilities such as not having a plan on how to present ideas as a group. Several comments from the teacher also recognized students as emerging leaders.

Student creativity was also recognized and resulted in 20% of the teacher's responses. Overall, the teacher recognized students' abilities to share ideas in their groups while brainstorming and prototyping. Students were also described as taking risks, which is important to creativity. Revision was identified as a challenging concept for students as they struggled with iterating on design feedback. About 15% of the teacher's comments were about student critical thinking. Students practiced critical thinking by analyzing information, generating and asking

questions, making decisions, and drawing conclusions. The teacher also suggested students practiced higher-order thinking by making inferences to thick questions. Only 6% of the teacher's comments were related to communication skills. In general, comments indicated students had challenges with communication. Particularly, students struggled with articulating ideas aloud while presenting the maps for feedback and during the presentations. Although challenges with certain skills were surfaced, design thinking offered an opportunity for students to practice these skills.

In addition to his assessment of students' Four Cs skill development, the teacher shared general thoughts about design thinking in classrooms. During his interviews, the teacher described design thinking as a powerful, worthwhile experience. He recognized how "…that experience, the kinetic and talk, even just the opportunity they had to talk about it, not just write about it" can offer a different type of learning experience for students. Overall, the teacher was pleased with the experience and expressed interest in participating in another design thinking challenge.

What challenges are anticipated by the educator for implementing design thinking within instructional plans? Findings from the teacher data suggest challenges around the time required for design thinking, the iteration process, and the needs statement. The time requirement for design thinking was clearly revealed as a challenge. Both the teacher and students commented about time restraints throughout interviews. During one of the last interviews, the teacher reflected if he could afford the time for projects like these when already feeling at capacity with the vast amount of curriculum to be covered. However, he further elaborated design thinking may require less time the more often it is practiced. Also during interviews,

several students expressed wanting more time for the design thinking activity they were working on that day.

Findings also present challenges associated with the process of iterating. During an interview, the teacher described how students struggled with digesting and incorporating feedback into their maps. He characterized revision as a difficult concept for students to grasp in other disciplines, such as writing. The researcher supported this notion by describing students as nervous and unsure during the iteration phase of design thinking. Challenges with iteration also materialized in the artifacts. At least 50% of the student groups met or exceeded expectations for all of the artifacts except for the map, due to lack of feedback incorporated into the designs. The teacher supported this finding by describing many groups as unsuccessful during presentations as those revisions were not identified or presented.

Another challenge during design thinking implementation involved the problem to be explored, which in this study was characterized by the needs statement. During an interview, the teacher posed the possibility that this design thinking challenge's needs statement, "Chief Chowig, a brave leader, and Gaspar de Portola, a religious man and leader, need to make a plan to share land and resources," may have been too advanced for these students. He described students as lacking maturity to analyze and understand the concept of sharing land and resources. This is another reason students may have struggled with maps.

Research Study Conclusions

After a thorough analysis of the research findings, four conclusions were determined for this study. Each conclusion, along with implications for practice, is discussed in this section. The first two conclusions are specific to student learning and the second two conclusions focus on

design thinking classroom implementation. Recommendations for practice are presented separately for the first two conclusions and together for the last two conclusions.

Conclusion One: Design thinking is an effective instructional practice for elementary student learning of the Four Cs of 21st century skills. The overarching purpose of this study was to explore the process and outcomes of integrating design thinking into existing elementary curriculum. This study focused on the strengthening of students' 21st century skills during design thinking. An analysis of the student and teacher data revealed design thinking to be an effective instructional practice for elementary student learning. Findings from the self-assessments indicate growth in all Four Cs skills. Additionally, thematic coding from the researcher notes and interview data suggest students practiced 21st century skills while participating in design thinking. This supports the work of researchers such as Carroll et al. (2012), Kwek (2011), Noweski et al. (2012), and Todd (1999) who claimed design thinking could cultivate 21st century skill development in education.

Participating in design thinking activities prepares students with fundamental skills for life in the 21st century (Todd, 1999). As design thinking is an effective practice for promoting 21st century skills, students essentially gain skills for future jobs and real-world problem solving. Levy and Murnane's (2007) research discussed the complexity of future workplace problems. During the third phase, Understand the Problem, students were challenged with defining complex problems in which they had to work through in the proceeding steps. By having the opportunity to solve ill-structured (Rittel &Webber, 1973) problems in design thinking, students can prepare for future real world problems. This supports the research from Vande Zande, Warnock, Nikoomanesh, & Van Dexter (2014) who proposed design thinking as a method for working on creative problem solving necessary for future satisfaction in life.

Design thinking can also be an effective instructional practice to foster skills beyond those associated with the 21st century movement. When integrated into the curriculum, design thinking can help students achieve academic standards. During this study, while practicing 21st century soft skills, students also learned about the conflict between Native Americans and the new settlers as part of the California third grade curriculum. They learned about new settlers coming to California, how resources and land needed to be shared, and exercised empathy towards both groups. They also practiced skills laid out in the lesson plans relating to English Language Arts Common Core State Standards (CCSS) and design standards published by Next Generation Science Standards (NGSS) and International Society for Technology in Education (ISTE). The student work artifacts demonstrated an informal measure of the social studies academic content. Although the acquisition of content knowledge was not a focus for this study, it presents an example of a potential curricular-integrated design thinking approach.

The outcomes from the curricular-integrated lesson plans in this study support the research from Scheer et al. (2012) promoting design thinking as a strategy for facilitating interdisciplinary projects. Further, these findings align to research from Goldman et al. (2014), Kafai and Resnick (2002), and Kolodner et al. (2003) who suggested the design thinking process can assist students with acquiring skills related to subject areas while building cognitive and social skills. Rotherham and Willingham (2009) argued curriculum intertwined with skills and knowledge as necessary for the 21st century learning. Design thinking can be an interdisciplinary instructional approach that combines academic content with 21st century skill development.

Recommendations for practice: Design thinking is effective for educators interested in incorporating more project types of instructional approaches that emphasize problem solving. It is a strategy to engage students in meaningful experiences that prepare them for real world

challenges and jobs; thus, cultivating 21st century skills. Razzouk and Shute (2012) in a research discussion expressed helping students learn to think like designers could prepare them for challenging situations in school, careers, and throughout life.

Integrating design thinking into existing academic content broadens the opportunities for design thinking as an instructional approach. When integrated into the curriculum, design thinking helps students achieve 21st century skills while focusing on academic content standards. To integrate into the curriculum, educators may consider beginning with outlining the instructional goals in their curriculum and using design thinking to reach those goals. While it may stand alone, design thinking is a powerful method to support a range of interdisciplinary content. Educators may consider various ways to assess academic outcomes as a result of design thinking. This study presented ideas for assessing 21st century skills and design thinking objectives, but it did not assess content knowledge as an outcome. Educators can gain a holistic understanding of their students' learning by also evaluating outcomes tied to the academic content standards.

Conclusion Two: Design thinking presents opportunities for interactive, collaborative learning experiences where students are interested in the assignment. As an instructional approach, design thinking proved to be an engaging learning experience for students. Part of this study focused on students' perceptions of design thinking learning activities. During various interviews, students overwhelmingly shared their excitement and enthusiasm. In fact, students had such a positive reaction to the experience they expressed wanting to participate in more design thinking challenges. Both teacher interviews and researcher field notes also acknowledged student engagement. The teacher repeatedly described students as on-task, working together, and having a genuine interest in the process. For instance

in an interview the teacher shared, “Again, they were very engaged. They had a genuine interest in finding out more information.” The researcher’s description of the classroom continually highlighted students exuding excitement verbally and physically upon commencement of each new phase. Findings suggest students’ level of enjoyment was magnified by the opportunity to work in a social setting. Student comments about excitement were often associated with working in their groups. This supports Carroll et al.’s (2010) research that described student engagement as a result of the social interactions during design thinking.

Engagement in the learning process is critical for the 21st century. Claxton (2007) advocated for a culture shift in the process of learning and learning dispositions. He claimed a 21st century education should cultivate a desire to learn. The different types of activities in design thinking can offer a new type of learning experience to engage students. Findings from student interviews suggest students were engaged from the different types of activities that were outside of their normal classroom activities. Students enjoyed playing an active role by doing something with their ideas and bringing them to life. This aligns to Carroll et al.’s (2010) research that reported students preferred participating in active learning activities provided by design thinking.

During this study, students worked collaboratively from the beginning to end. Each design thinking phase had unique objectives in which students were required to achieve collaboratively. Results from the self-assessment found students had the highest confidence in collaborative skills after participating in the challenge. Collaboration also contained the highest number of coded passages in the thematic coding of interviews, self-reflections, and field notes. These findings support the work of Kangas et al. (2013) whose research revealed the nature of design as inherently collaborative. For example, students constantly shared ideas while making group decisions to design questions, brainstorming solutions, and designing and iterating on their

products. These findings align to Kolodner et al. (2013) who described sharing and discussing ideas as a natural part of designing.

Students in this study shared they achieved a better product as a result of working collaboratively. This result aligns to the National Education Association (2012) who explained collaboration yields more holistic results since products are developed from multiple varying perspectives. By employing design thinking, students can experience how combining and refining ideas with others can help them achieve solutions they may not have achieved on their own.

Findings suggest students practiced communication, creativity, and critical thinking skills all under the umbrella of collaboration. Students had to consider input from their group members to decide how to handle varying viewpoints. This supports the idea that a student must be able to connect with others while communicating and collaborating in order to innovate (National Education Association, 2012). This also aligns to Luka (2014) who recognized during design thinking students applied creativity, critical thinking, and communication all in a collaborative manner. As students collaborate during design thinking they exercise a willingness to listen to other's ideas, take risks, and share their ideas with others. A collaborative classroom culture is instilled as a result.

These findings are important as collaboration is a crucial skill for employers. The Conference Board (2006) and OECD (2005) shared research indicating employers rank collaboration as a key competency for 21st century learning, which is due to a growing globalized world, the rise of technology, and flattened corporations (Friedman, 2005; Jerald, 2009; National Education Association, 2012; Trilling & Fadel, 2009). By employing a pedagogy that cultivates collaborative skills, teachers can prepare students for current and future jobs. The radical

collaboration within the design thinking mindset (Carroll et al., 2010) can help students build empathy, weigh different viewpoints, build and refine social skills, and ultimately prepare them for the real world.

Levine (2012) presented the idea most students are excited about school during the early years, but the excitement fades as learning stops being fun. Whether it is majority of the students or just a handful, teachers are challenged with finding new ways to engage students. Findings from the teacher indicate design thinking could engage students who are not typically engaged in classroom activities. The literature reviewed for this study did not expose any specific studies focused on methods to engage different types of students in the classroom. However, it is important for practitioners to recognize employing design thinking as an instructional approach could provide a way to reach a wider range of students. Students who typically struggle with "fill-in-the-blanks" may thrive from participating in design thinking in the classroom. Students would be challenged to think in new ways and cultivate a positive attitude towards learning.

Recommendations for practice. Noel and Liub (2017) suggested the greater engagement students have in school; the more likely they will be successful in the future. Educators may consider design thinking as an instructional approach to engage students. Although engagement is a natural outcome of design thinking, students may be further interested when becoming involved in selecting the topic for design thinking. By embedding their interests, the design thinking instructional strategy becomes even more powerful. Additionally, design thinking may be considered as an inquiry-based instructional strategy for engaging students who may not typically be engaged. If not implemented for the whole class, design thinking could be applied during centers, lunch groups, or afterschool activities to engage students. Overall, design

thinking helps develop a sense of lifelong learning that would shape the skills and attitudes for a successful future (Wrigley & Straker, 2017).

As the literature suggests, collaboration is a necessary skill for students to practice. Educators may consider design thinking as an instructional approach to help build students' collaborative skills, such as sharing responsibilities, exercising flexibility, and working in diverse teams. While students more often have opportunities to work in pairs, working in design teams allows students to practice weighing varying viewpoints. It is recommended to consider strategic grouping and size, such as groups of three or more to enhance collaboration. For students who are apprehensive towards group work, conducting a design thinking challenge may provide an experience for them to recognize a different, more complex outcome as a result of working collaboratively.

Conclusion Three: Design thinking involves a specific set of phases each that is essential to the process. At its core, design thinking is a mindset and a process (Luka, 2014). The design thinking process as an instructional approach provides a framework for teachers to facilitate constructivist learning in their classrooms. During this study, students actively collaborated at each phase as they constructed knowledge and their own meanings. Each phase in the design thinking process allowed for the opportunity for students to practice different skills.

The collaborative nature of the design thinking process helps bring social learning into the classroom. Social learning theories from theorists like Vygotsky or Dewey have been praised in education for a long time. While specific goals were tied to each design thinking phase, those phases created the process necessary for constructivist learning. A quote from the teacher presented the active, social learning nature of design thinking, "…you can read things in books um, but that experience, the kinetic and talk, even just the opportunity they had to talk about it,

not just write about it, to talk about it I thought was very powerful." Students' comments suggested how the design thinking experience allowed them to construct their own meanings. For example, a student emphasized this point by describing how he enjoyed being able to do something with his ideas, "Instead of just like writing something down like a plan and you don't actually get to do it" (Liam). Findings from this study support the work of Noweski et al. (2012) and Scheer et al. (2012) who argued design thinking in education could offer the framework to support constructivism. They described design thinking as a formalized process for teachers to realize constructivist learning in their classrooms. While constructivist learning can be challenging to facilitate, researchers have suggested employing instructional frameworks in the classroom can help (Gardner, 2010; Scheer et al., 2012; Wagner, 2011). Findings from this study suggest design thinking can be a formal, pedagogical framework to help practice social learning theories. This also aligns to Goldman et al. (2014) who recognized the deep collaboration during design thinking supports social processes of learning.

In addition the connection to constructivism, each phase in the process offered opportunities for students to practice different skills. The objectives tied to each phase were necessary for fostering the development of 21st century skills. Findings from the teacher self-reflection drew connections between the objectives of the design thinking phases and skill development. For example, in his description of design thinking the teacher described students as analyzing a problem which connected to information analysis, an important skill for critical thinking. He also described design thinking as brainstorming questions, made a prototype which is a skill important to creativity. In addition to the self-reflection, the thematic coding revealed specific skills practiced during each phase. For instance, while the Ask Tons of Questions phase allowed opportunities for students to practice generating and asking questions, the Create a

Prototype phase fostered skills such as sharing ideas aloud, creating ideas, and risk taking. Each phase is important for achieving the potential of design thinking in a classroom. This aligns to the work of Todd (1999) who described design thinking as fostering different skills such as investigating, creating, planning, making, testing, improving, and evaluating. If carefully implemented, design thinking offers a connection between pedagogy research and practice, while fostering 21st century skills.

Conclusion Four: Design thinking requires deliberate efforts from the teacher for successful classroom implementation. Unique planning and preparation was required from the teacher and researcher to implement the design thinking challenge. A goal of this study was to integrate design thinking into existing curriculum. Thus, at the beginning of this study the teacher and researcher decided on a design thinking challenge integrated with California third grade social studies standards. In this case, the researcher drafted the interdisciplinary design thinking lessons, which required thoughtful effort and research. The researcher was also careful to include design principles in the lesson plan since the teacher did not have any prior knowledge of design thinking. Each week, the teacher met with the researcher to discuss the instructional plans for the phase. In a typical classroom environment, a teacher would most likely be responsible for determining curriculum integration, learning about design thinking, and then writing lesson plans. All of these activities take time, attention, and the desire to implement. The findings from this study aligns to Carroll et al. (2010) whose research suggested it takes time and effort to integrate academic standards into design thinking.

In addition to lesson planning, the researcher and teacher met before the study to discuss the design thinking process and philosophy. Although the teacher and researcher worked closely together, the teacher never received formal training in relation to design thinking. As such,

implementing design thinking was a pedagogical shift and a new way of thinking for the veteran teacher. While pedagogical content knowledge was a part of teacher preparation in the 1990s (Morey, Bezuk, & Chiero, 1997), design thinking had not gained industry popularity until the last fifteen years (Brown, 2008). Thus, as supported by finding from the teacher self-reflection, the teacher did not have prior knowledge of design thinking as a concept or pedagogical strategy. Creating a classroom culture for design thinking is important (Carroll et al., 2010). This was evident during the Highlight and Fix phase of the design thinking process. Students did not fully grasp the concept behind design iteration, nor did they demonstrate the abilities to integrate teacher feedback into their designs. The process of receiving feedback and then being asked to apply it to their maps was confusing and uncomfortable. The design thinking concept of "failing early and often" (Carroll et al., 2010, p. 41) was not cultivated during this phase. Therefore, students did not successfully iterate on their maps. In this case, students did not embrace the testing and rapid prototyping (Hasso Plattner Institute of Design, 2017) or the self-reflective skills important to design thinking (Schön, 1983). The results may have varied if a design culture was established in the classroom as a result of teacher training and preparation.

Findings from this study also suggest deliberate efforts were made to facilitate activities throughout the design thinking implementation. Findings from the teacher indicated several strategies he employed during the activities, such as strategic grouping and scaffolding. On several occasions, the teacher also shared reflections on areas to improve such as more modeling. These findings highlight the importance of the facilitation techniques required to implement design thinking successfully.

As efforts are necessary for curriculum integration, lesson planning, learning about design thinking, and closely facilitating activities, findings suggest design thinking takes more

time than typical classroom instruction. Both the teacher and students recognized the time constraints during the design thinking activities. Several comments described the teacher's desire to have more time to facilitate activities. He also reflected about having enough time for projects, such as design thinking. However, as indicated by the teacher, a design thinking implementation should take less time as the culture and process becomes more familiar.

Conclusions Three and Four: Recommendations for practice: The recommendations for practice for conclusions three and four are combined as they both pertain to integrating design thinking in classrooms. The first recommendation is for school administrators about design thinking and professional learning. To employ design thinking in schools, design thinking professional learning opportunities for educators are important. Professional learning options include formal workshops, courses, webinars, or partnering with experts such as a researcher. As this case study reveals, educators receive professional learning and mentoring when partnering with a researcher. Allocating time for professional learning about design thinking is required for implementations to be successful.

Additional recommendations are specific for educators interested in integrating design thinking into their classroom. While this study applied the LAUNCH Cycle (Spencer & Juliani, 2016), educators may want to consider the various design thinking frameworks best suitable for their classroom. For example, different frameworks may be available for students in elementary, secondary, or higher education. Additionally, educators may prefer the activities or resources that accompany the framework. While there are several frameworks, they all share the core principles of design thinking and choosing one will provide the methodology for getting started.

Integrating design thinking into existing curriculum helps with time, effectiveness, and student learning. For lower elementary grades, it is recommended to keep activities open-ended,

while setting parameters and redirecting when necessary. It is important to focus on cultivating a culture of iteration and applying feedback, as it is a natural part of the design process. Other considerations include strategic grouping and employing more modeling of design thinking concepts. Planning for the needs statement and ensure the concept is achievable for the grade level is also important for success. All of these suggestions will help establish a culture for a successful design thinking implementation as well as enhance student learning.

Design thinking is an opportunity for educators to include more social learning theory in their classrooms. The formalized instructional process offered by design thinking allows for educators to more easily apply these theories, such as constructivism. However, each phase in process must be realized in order to achieve the results. However, while each phase is important they do not always need to be linear. This study applied a linear approach, yet the Hasso Plattner Institute of Design (2010) suggested it is not uncommon for designers to work through the stages in various orders to refine a solution. Educators may consider adapting a flexible approach as opposed to the step-by-step process.

Recommendations for Scholarship

While there is some research around design thinking in education, it is still an emerging concept. There is a vast amount of research to be done in this area to truly understand the value and place of design thinking in education. Research on best practices for facilitating design thinking for all grade levels would be beneficial. Particularly, it is recommended to conduct more research in elementary school contexts. One of the findings from this study suggested design thinking as an instructional approach could engage students who are not typically engaged in classroom activities. Further research focusing on student engagement during design thinking would be valuable.

While this study applied the Four Cs framework to explore learning, it is recommended to further research on design thinking integrated into the curriculum. If integrated with academic content standards, research on assessing students' learning of the content would be useful. Further exploration into integrating design thinking into various disciplines would also be beneficial. In particular, suggestions for future researcher include effective ways to integrate design thinking with educational standards, how learning outcomes could be measured, and the effectiveness for teaching content knowledge.

Another recommendation for research involves the transparency of the phases in the design thinking process for students. During this study, the teacher indicated it was not necessary to highlight each phase in the design thinking process until after the challenge, in effort to give students a reference for the phases. Future research investigating student involvement in the phases would be beneficial. For example, it is beneficial for students to know the name and objective of each phase, or does it not matter as long as it is embedded within the lesson? Investigating this idea for different grade levels would be helpful, as researchers may find varied results depending on the grade level.

As the challenges with iteration were prevalent in this study, is it suggested to further research on iteration within design thinking. Future research focusing on effective strategies for providing feedback and helping students apply feedback in the context of design thinking would be valuable. For instance, investigating applicable feedback theories or activities to help students better grasp the concept. It would also be beneficial to learn more about why students struggle with iteration in design thinking. Findings in this area may also inform future strategies for teaching iteration and revision in classrooms.

Limitations and Study Validity

This study was limited to a teacher and students in a third grade public school classroom in San Francisco Bay Area, California. Since the sample was small, results cannot be generalized across all elementary school classrooms. While this study does not accommodate generalizations for broader classroom contexts, the results can be used to inform teachers on the process and outcomes of implementing design thinking in elementary classrooms. Another limitation is the self-reported assessment data from students. The researcher worked under the assumption that students understood the questions being asked, and students answered honestly without worrying about their images.

To ensure validity in a study, trustworthiness must be granted through credibility, transferability, dependability, and conformability (Lincoln & Guba, 1985). This study applied measurements to ensure trustworthiness and strengthen validity. Not only does the researcher's elementary teaching and curriculum background assist with the credibility of the study, she also placed measurements to further credibility. The researcher visited the research site for prolonged visits to establish relationships with the teacher and student participants (Creswell, 2014). Additionally, rigorous data analysis and the use of a peer-reviewer ensured accuracy of data.

Transferability was aided by the description of the case, particularly the grade level, teacher-student ratio, and information about the teacher's previous experience with design thinking. Dependability was strengthened through research insights into the problem, data collection protocols, and lesson plans laid out in this study (Creswell, 2014; Yin, 2018). The presentation of protocols and lesson plans allow for future replication of the study. Last, the researcher practiced reflexivity by recording self-reflections to clarify bias throughout the study.

The reflections contributed to the accuracy of data interpretation, which strengthened conformability and supported internal validity.

Closing Comments

Discovering instructional approaches that promote active engagement, collaboration, and innovation is necessary to prepare students for success in the 21st century and beyond. Yet, exclusively focusing on 21st century skills is not enough. With the growing number of academic content standards educators must address, it is important for instructional approaches to blend 21st century skills with academic content. Formalized instructional approaches that marry these concepts are limited. However, findings from this study suggest design thinking, if integrated into the curriculum, can be one of those approaches.

Insight into both the teacher and students during this case study was an eye-opening experience. Students were able to share thoughts and knowledge throughout each step of the design thinking process. Their continuous engagement and perceptions on skill development provided a unique view into the impact of design thinking. Partnering with the teacher unveiled the processes involved in designing and implementing design thinking into classroom curriculum. Not only did his insights shed light on design thinking and skill development, but they also helped reveal strategies and suggestions for practical implementation for this approach.

It is the hope of the researcher that the results of this case study will provide educators with an example of conducting design thinking as an instructional strategy in classrooms; that they can gain insights into the specific steps involved in implementing design thinking into classroom curriculum, primarily in elementary contexts; that processes and outcomes of this study may inform the development of professional learning on design thinking.

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APPENDIX A

Meeting Agendas

Meeting #1 Agenda

Date/Time:

Attendees:

Tasks

1. Introduce study. Discuss study time and data requirements.
2. Provide Information Sheet. Discuss privacy and confidentiality related to the study.
3. Ask teacher to prepare existing data and think about curricular topics for the next meeting.

Meeting Notes:

Meeting #2 Agenda

Date/Time:

Attendees:

Tasks

1. Introduce the design thinking process. Review example design thinking challenges.
2. Review classroom curriculum. Select a topic for design thinking challenge.
3. Discuss and define implementation schedule and start date.
4. Discuss flow of lesson plan implementation.
5. Collect existing data.

Meeting Notes:

APPENDIX B

Documented Permission from d.loft for Use of Curriculum

Permissions Question - d.loft

Kristin Van Gompel 'student' <kristin.vangompel@pepperdine.edu> Wed, Oct 3, 2018, 8:57 AM
to maureen

Dear Dr. Carroll,

My name is Kristin Van Gompel and I'm currently working on my dissertation focused on exploring design thinking in elementary classrooms. Currently, I'm in the process of writing the curriculum-integrated desi lesson plans with my participating teacher to start data collection.

While browsing for ideas, I found inspiration on your d.loft Educator-Designed Curriculum page. In particular, the lesson focused on designing a co-habitable space for native americans. I'd love to borrow the ma lesson, but modify the lessons for 3rd grade learners and to better fit my study. I could not find any information on the website about sharing, copyright, permissions, etc. I was hoping you could help me determi may borrow the inspiration from this lesson while providing attribution to the author/organization/etc.

I appreciate any advice you may have. Thank you so much for your time!

Thank you,
Kristin Van Gompel

Maureen Carroll <maureen@limedesignassociates.com> Wed, Oct 3, 2018, 10:01 AM
to me

Hi Kristen,

I am glad you found our resources helpful. Please feel free to modify or use in any way that you would like. We wanted to share this resource as widely as possible. I would love to know how your lesson goes!

Best,

Maureen

Maureen Carroll, Ph.D.
Founder, Lime Design Associates
www.limedesignassociates.com
Lecturer, d.school Stanford University
maureen@limedesignassociates.com
925 963-8596
twitter: @limedsgn
Lime Design on Facebook

Kristin Van Gompel 'student' <kristin.vangompel@pepperdine.edu> Fri, Oct 5, 2018, 1:11 PM
to maureen

Hi Dr. Carroll,

Thank you so much for getting back to me!

The website really is a great way to share ideas. I will be sure to reference d.loft for the inspiration in the written part of my study.

I will let you know how the challenge goes!

Thanks so much,
Kristin

APPENDIX C

Lesson Plan Template

DESIGN CHALLENGE: [title]

LESSON PREVIEW

Lesson Topic: [main idea for lesson]

LAUNCH Cycle Phase(s): [phase or phases involved in the lesson]

Estimated Time: [duration of lesson]

Objectives: [what will students learn]

Standards: [which standards align to the lesson]

Vocabulary: [definitions for key vocabulary]

LESSON PREPARATION

Materials: [list of materials necessary for lesson]

Tasks: [what the teacher needs to do to set-up]

LESSON OUTLINE

[list teacher and student tasks involved in the lesson]

**this lesson plan template is adapted from the book, LAUNCH: Using Design Thinking to Boost Creativity and Bring Out the Maker in Every Student (Spencer & Juliani, 2016).*

APPENDIX D

Lesson Plans and Materials for Design Thinking Challenge

DESIGN CHALLENGE: Designing a Shared Space for
Native Americans and Early Settlers

LESSON PREVIEW

LAUNCH Cycle Phase(s): Phase 1: Look, Listen, and Learn

Lesson Topic: Role Play Debate

Grade: 3

Estimated Time: 45 mins.

Objectives:

- Empathize with historic people, Native Americans and early settlers, evaluating motivations, impact, and perspectives
- Demonstrate the ability to make inferences based on background knowledge and newly acquired knowledge
- Develop research skills individually and collaboratively

Standards:

California History Social Studies

- 3.2 Students describe the American Indian nations in their local region long ago and in the recent past.
- 3.2.1 Describe national identities, religious beliefs, customs, and various folklore traditions.
- 3.2.2 Discuss the ways in which physical geography, including climate, influenced how the local Indian nations adapted to their natural environment (e.g., how they obtained food, clothing, tools).
- 3.2.4 4. Discuss the interaction of new settlers with the already established Indians of the region.

- 3.3.1. Research the explorers who visited here, the newcomers who settled here, and the people who continue to come to the region, including their cultural and religious traditions and contributions.

Common Core State Standards English Language Arts (CCSS)

- CCSS.ELA-LITERACY.W.3.8. Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.
- CCSS.ELA-LITERACY.SL.3.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 3 topics and texts*, building on others' ideas and expressing their own clearly.
- CCSS.ELA-LITERACY.SL.3.3. Ask and answer questions about information from a speaker, offering appropriate elaboration and detail.
- CCSS.ELA-LITERACY.L.3.3. Use knowledge of language and its conventions when writing, speaking, reading, or listening.

Next Generation Science Standards (NGSS)

- MS-ETS1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

International Society for Technology in Education (ISTE)

- 4C. Students develop, test and refine prototypes as part of a cyclical design process.

Vocabulary:

- Interview: to question or talk with (someone) to get information
- Press Conference: an interview or announcement given by a public figure to the press by appointment
- Debate: to discuss a question by considering opposed arguments

<u>LESSON PREPARATION</u>

Materials:

- Bios sheets (for teacher and students to reference)
- Student Research sheets

- Student Press Conference sheet
- Student Press Conference Top Four sheet

Tasks:

- Print and review Bio Sheets
- Research any relevant information about each characters, if necessary
- Determine student pairs?

LESSON OUTLINE

Activity 1: Role Play Debate - Gaspar vs. Chief (20 mins.)

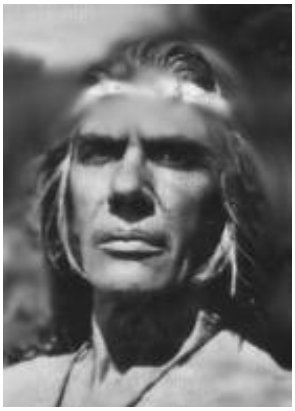
- Introduce activity to students. Distribute Research sheets and review questions with the class. Students should be listening for characters to explain their points of view and needs. Direct students to take notes as the teachers assume characters in this debate.
- Teachers will play roles of the characters indicated in the Bio Sheet. Teachers take turns reading the sheets aloud as the "debate" to present their background and needs to the classroom. Teachers may decide on the level of theatrics based on personal comfort (i.e. costumes, acting, etc.).

Activity 2: Developing Interview Questions (25 mins.)

- While the debate is still fresh in students' minds, have them write interview questions.
- Distribute Press Conference sheet to students. Consider explaining what a press conference is to help students understand the connection. Also distribute the Information sheet (same as bio sheet) for students to reference while they are developing questions.
- Split students into pairs. Direct students to write three interview questions for Chief and Gaspar.
- Partner pairs with another group so they are now in groups of four. Direct students to compare questions and decide on the Top four questions for the group. One student from the group should write the Top 4 questions on their groups new paper.
- Collect all papers from each group. Students will have the opportunity to ask these questions during the next lesson.

Biography Sheets

Chief Chowig



I am Chief Chowig. I am Chief of my people. We live by the ocean. Our ocean is filled with fish, squid, crabs, and many other foods we eat everyday. We grow corn, beans, and squash. They grow very well together. My people are peaceful. We are close to our families and believe the earth gives us everything we need. We appreciate their gifts of food, water, beauty, clothing and shelter. We live in harmony with the land.

We value our freedom to go where we want and do as we please. We believe in respect for our land, our people and the earth, so we do not fear our people will do bad things. However, we have heard from far away places that white men are coming to take over our homes, tear our families apart, and tell us what we should believe. I tell my people everything will be fine, but they have heard news of other places in the Central Valley where the Yurok live . . . white men have come and have ripped families apart, forced them to eat their food, and put them in a place where they have no freedom to leave.

They work hard daily doing meaningless work like making bricks day after day, night after night. They have heard the Yurok people have died from sickness they have never seen before. And those who try to escape are beaten. I try to calm my people, but they grow worried, and sad every day. As Chief Chowig, I have made a promise to protect my people and not fear the future of change. We know change will come, we are not afraid, but we cannot be expected to give up our culture, our food, our beliefs and our way of life. My people everything to me.

**this biography description is adapted from the d.loft design thinking lesson (Ward & Yamada, n.d.).*

Gaspar de Portola

My name is Gaspar De Portolá. I am a high-ranking army officer, sent from my native country, Spain, to explore and help my people start a new life in this land. My country is interested in taking this land because of its amazing resources. This land has the ocean, the forest, the desert, and the mountains . . . all regions filled with valued resources.

My personal interests are to lead expeditions to establish settlements on this land while assisting Father Junípero Serra. I will establish the military bases and Father Serra, who is a priest from my country, will establish missions. Father Serra and his missionaries will teach these unruly Natives the way of God and ways of life to better themselves. Together, we will travel across this land to build these settlements.

I have heard stories that the Natives here think we are only here to hurt them. I have heard those who speak both languages say we bring disease and make them sick. We make them work hard every day, but we are only here to help. The hard work the Natives do on our land will bring them closer to God. They should appreciate the food, shelter and work we have so graciously provided them.

As Father Serra says, God says we must work hard to reach the paradise he prepares us for and our work is helping them to reach this place of paradise. They will live better lives. We are here to help them and seek peace. I do not understand their language but I know they need us and our help. Learning our ways and helping them is what we want for these people. I wish I could convince them of this.

**this biography description is adapted from the d.loft design thinking lesson (Ward & Yamada, n.d.).*

Names:

Research Sheet

Chief Chowig

What did the Native Americans believe?

_____

_____

_____

_____

How did Native Americans get their food?

_____

_____

_____

_____

What were Native Americans' homes and clothing like?

_____

_____

_____

_____

What were some challenges the Native Americans' experienced?

_____

_____

_____

_____

Names:

Research Sheet

Gaspar De Portolá

What did Gaspar De Portolá and the newcomers believe?

_____

_____

_____

_____

How did the newcomers get their food?

_____

_____

_____

_____

What were the newcomers' homes and clothing like?

_____

_____

_____

_____

Why were the newcomers interested in living in California?

_____

_____

_____

_____

Names:

Press Conference Sheet

Directions: Write three interview questions for each person below:

Chief Chowig

1. _____

_____

2. _____

_____

3. _____

_____

Gaspar De Portolá

1. _____

_____

2. _____

_____

3. _____

_____

Names:

Press Conference: Top Four Questions

Directions: Write the Top Four questions from your group.

Chief Chowig

1. _____

_____

2. _____

_____

Gaspar De Portolá

1. _____

_____

2. _____

_____

DESIGN CHALLENGE: Designing a Shared Space for
Native Americans and Early Settlers

LESSON PREVIEW

LAUNCH Cycle Phase(s): Phase 2: Ask Tons of Questions

Lesson Topic: Press Conference

Grade: 3

Estimated Time: 30-40 mins.

Objectives:

- Empathize with historic people, Native Americans and early settlers, evaluating motivations, impact, and perspectives
- Demonstrate the ability to make inferences based on background knowledge and newly acquired knowledge
- Develop research skills individually and collaboratively
- Ask questions to understand more about the needs of each side

Standards:

California History Social Studies

- 3.2 Students describe the American Indian nations in their local region long ago and in the recent past.
- 3.2.1 Describe national identities, religious beliefs, customs, and various folklore traditions.
- 3.2.2 Discuss the ways in which physical geography, including climate, influenced how the local Indian nations adapted to their natural environment (e.g., how they obtained food, clothing, tools).
- 3.2.4 4. Discuss the interaction of new settlers with the already established Indians of the region.
- 3.3.1. Research the explorers who visited here, the newcomers who settled here, and the people who continue to come to the region, including their cultural and religious traditions and contributions.

Common Core State Standards English Language Arts (CCSS)

- CCSS.ELA-LITERACY.W.3.8. Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.
- CCSS.ELA-LITERACY.SL.3.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 3 topics and texts*, building on others' ideas and expressing their own clearly.
- CCSS.ELA-LITERACY.SL.3.3. Ask and answer questions about information from a speaker, offering appropriate elaboration and detail.
- CCSS.ELA-LITERACY.L.3.3. Use knowledge of language and its conventions when writing, speaking, reading, or listening.

Next Generation Science Standards (NGSS)

- MS-ETS1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

International Society for Technology in Education (ISTE)

- 4C. Students develop, test and refine prototypes as part of a cyclical design process.

Vocabulary:

- Interview: to question or talk with (someone) to get information
- Press Conference: an interview or announcement given by a public figure to the press by appointment

LESSON PREPARATION

Materials:

- Student Press Conference Top Four sheet (from Lesson 1)

Tasks:

- Teacher brainstormed answers for each question

LESSON OUTLINE

Activity: Press Conference – Gaspar, Chief, and the people (30-40 mins.)

- Excuse students to Learning Center on the rug in their groups of 4. Distribute the Top 4 questions sheet back to each group. Assign one student in each group to take notes on their sheet during the press conference.
- Explain to students that the goal of today is to gather as much information about the needs of Chief Chowig and Gaspar de Portola. After this exercise they will be asked to compare and contrast the needs of each person and their people.
- Tell students that today we will be holding the press conference. (Ask students to describe what they remember about press conference.)
- Student groups will take turns asking Chief Chowig and Gaspar de Portola their questions.
- One student from each group should be taking notes on their sheet during this exercise.
- Collect papers at the end of the exercise.

Top Four Questions Pre-Work: Answer Guide for Students Questions

Chief Chowig	
Questions	Ideas for Answers
Are you sure that you can promise of protecting your people?	I am not sure. I am trying to do everything I can to protect my people and our culture, but the newcomers are taking our lands and resources.
Do you have a wife or kids, and if so how old are your kids?	Yes, and three children. Their ages are 14, 18 and 22.
How did you feel when the Spanish came?	I felt scared because we my people has lived here for hundreds of years and we did not know what the newcomers wanted.
Was it hard to catch animals?	It is sometimes hard to catch animals but mainly during the cold weather. My people have hunted here for a long time. We respect our animals and try to give back to the land.
How do you feel about the white man?	I felt scared because we my people has lived here for hundreds of years and we did not know what the newcomers wanted.
How big is your group?	There are many many of us in my tribe...maybe 200.
How did it feel when your people were getting sick?	It hurt me to see my people get sick. I wanted to protect my people and I feel like maybe I failed.
How did it feel when your people were working hard?	I did not know if some of my people chose to work because they converted to the Spanish's faith, or if they were forced to work. Either way, I was angry with the newcomers since they were disrupting the way we have lived for a long time.
Why did you not fight for this right?	I have fought for my people. I try to be peaceful with the newcomers by offering gifts or by trading with them...but sometimes they do not listen to me. They have many men with weapons that we have not seen before. I am trying to do what is best for my people.
How did you feel when you were being separated from your family?	Thankfully, I have not been separated from my family yet. But many families in my tribe are being separated to work for the newcomers.
How did you feel about being chief?	I am happy to be chief. My father was chief, his father was chief, his father's father was chief. This is just a hard time to be chief because we have never been faced with anything like this before.
How do your people feel?	My people are confused, upset, and worried. Our way of life is being disrupted and we do not to do work for them.

Gaspar de Portola	
Question	Ideas for Answers
Are you going to kill and hurt the natives with disease?	It is never my goal to hurt the natives. We try to work together and trade with the natives. I try to tell them this.
Why did you make them work harder?	It is important for us to build missions and other buildings. We need strong men to work that can work hard. The natives have a lot of strong men who can work and help us build.
How many times were you sent to war?	I served as a soldier in the Spanish army in Italy and Portugal. Then, I was sent here to the new lands to establish settlements for my country.
Did you have a wife?	Yes. I married a woman that I met here.
How old are you?	The year is 1769 and I am 53 years old.
How do you feel?	I am happy that my country arrived here before other countries so that we can make settlements on this land. I hope the natives decide to join our ways.
What kind of languages did you speak? (x2)	Spanish. I am learning small words in the language that the natives speak.
Why did you want the natives to follow your ways?	This land has not been claimed by another country. We are establishing settlements here with our missions and we hope the natives decide to join our ways since our people will be moving here.
Why are you making the indians work for you?	My men are dying because they are working so hard. We need more men to help us. Some of these natives have converted to our faith and want to work with us. We are also trading with some of these natives for their work.
How did you become a high ranking army officer?	I was named a high ranking officer because I served as a soldier in the Spanish army when my country went to Italy and Portugal.
What do you like about your country?	I love my country and my king, King Charles III.

DESIGN CHALLENGE: Designing a Shared Space for
Native Americans and Early Settlers

LESSON PREVIEW

LAUNCH Cycle Phase(s): Phase 3: Understand the Process or Problem

Lesson Topic: Define Needs

Grade: 3

Estimated Time: 45 mins.

Objectives:

- Empathize with historic people, Native Americans and early settlers, evaluating motivations, impact, and perspectives
- Demonstrate the ability to make inferences based on background knowledge and newly acquired knowledge
- Develop research skills individually and collaboratively
- Define a needs statement for the issue

Standards:

California History Social Studies

- 3.2 Students describe the American Indian nations in their local region long ago and in the recent past.
- 3.2.1 Describe national identities, religious beliefs, customs, and various folklore traditions.
- 3.2.2 Discuss the ways in which physical geography, including climate, influenced how the local Indian nations adapted to their natural environment (e.g., how they obtained food, clothing, tools).
- 3.2.4 4. Discuss the interaction of new settlers with the already established Indians of the region.
- 3.3.1. Research the explorers who visited here, the newcomers who settled here, and the people who continue to come to the region, including their cultural and religious traditions and contributions.

Common Core State Standards English Language Arts (CCSS)

- CCSS.ELA-LITERACY.W.3.8. Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.
- CCSS.ELA-LITERACY.SL.3.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 3 topics and texts*, building on others' ideas and expressing their own clearly.
- CCSS.ELA-LITERACY.SL.3.3. Ask and answer questions about information from a speaker, offering appropriate elaboration and detail.
- CCSS.ELA-LITERACY.L.3.3. Use knowledge of language and its conventions when writing, speaking, reading, or listening.

Next Generation Science Standards (NGSS)

- MS-ETS1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

International Society for Technology in Education (ISTE)

- 4C. Students develop, test and refine prototypes as part of a cyclical design process.

Vocabulary:

- Venn Diagram: a graph that helps you organize data, to show the similarities and differences between two objects.
- Need: something that is necessary or required to live (in this context).
- Needs statement: provides a clear explanation of an issue that is presented.

LESSON PREPARATION

Materials:

- All Notes from Lessons 1 & 2, placed into Group packets
- Bios sheets
- Student Research sheets
- Student Press Conference sheet
- Student Press Conference Top Four sheet
- Venn Diagram sheet (one per group)

Tasks:

- Draw Venn Diagram on the white board, similar to what student's see on their sheets

LESSON OUTLINE

Activity 1: Introduction to Venn Diagram (10 mins.)

- In their groups of four, excuse students to Learning Center area on the rug.
- Remind students that over the last two activities they have learned a lot about Chief Chowig and Gaspar de Portola. Explain to students that the goal of today's activity is to define the needs of Chief Chowig (and his people) and Gaspar de Portola (and his people).
- Draw a Venn Diagram on the white board to represent what students will be doing in this activity. Explain how compare and contrast works in a Venn Diagram.
- Explain to students that today they will write the needs of Chief Chowig in the left circle, Gaspar de Portola in the right circle, and similarities in the middle. Consider defining what a "need" may mean in this context.
- Model a think aloud to show students how they should look at their notes in their packet to figure out the needs. Demonstrate transferring one fact to one of the circles.

Activity 2: Venn Diagram in Student Groups (20 mins.)

- Distribute the group packets and Venn Diagram sheets to students.
- Explain that students have "X" amount of time to complete the Venn Diagram in their groups. Remind students to find this information in their packets and from memory.

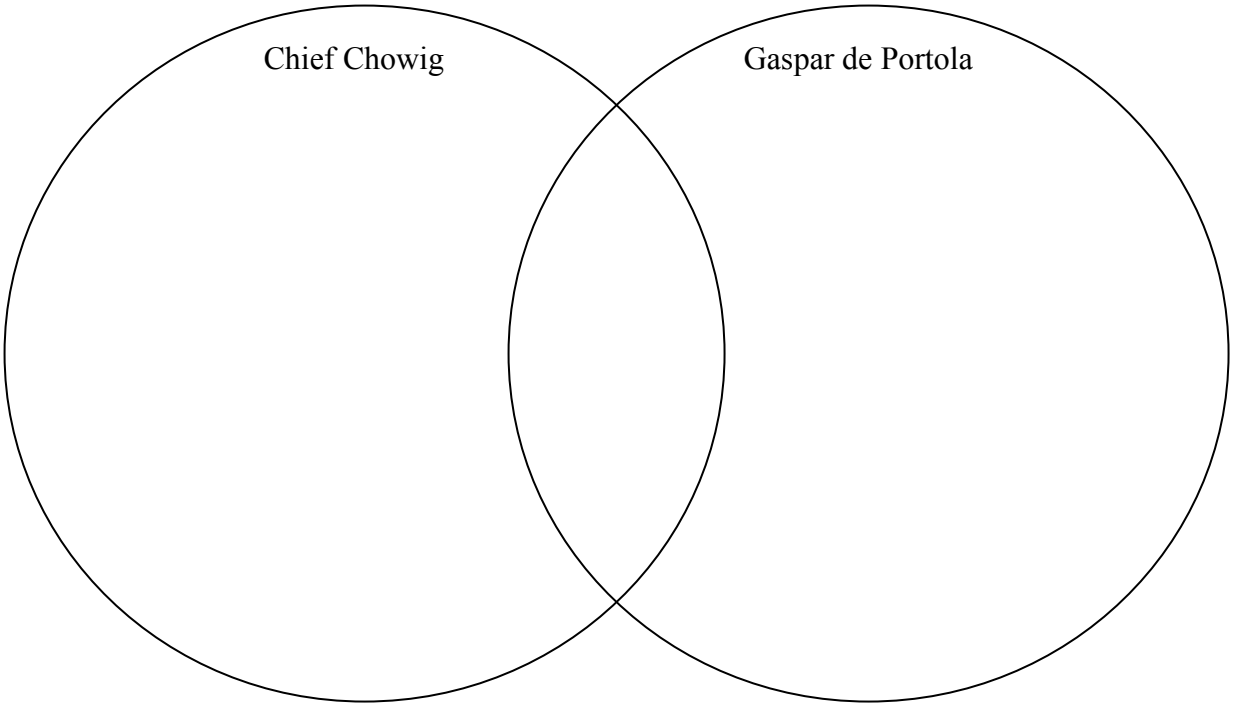
Activity 3: Defining the Needs Statement (15 mins)

- After students complete Venn Diagram, ask them to rejoin the Learning Center rug area to discuss their work.
- Call on students to share answers from each side and similarities. Complete the Venn Diagram on the whiteboard as students are sharing their answers with the class.
- Explain to students we will define a needs statement from this work. Explain that a needs statement provides a clear explanation of an issue that is presented. Instead of looking at the small details for each need, students should consider the larger needs of each group.
- Help students arrive to a needs statement. Teacher should use judgement on how much facilitation this requires for their class. Example needs statements are as follows:

- Example 1: “Gaspar de Portola, a determined and religious man, and Chief Chowig, a caring and concerned leader, need to live in a common place where they can practice their beliefs and cultures.”
- Example 2: “Gaspar de Portola, (adjectives), and Chief Chowig (adjectives) need to live in a common place where we can practice their beliefs and cultures.”
- Explain to students that these activities have helped us define the problem/issue. In the next lesson, we will brainstorm ideas on how these two groups of people may live together peacefully.

Compare and Contrast: <u>Needs</u> of Chief Chowig and Gaspar de Portola

Names in Group:



DESIGN CHALLENGE: Designing a Shared Space for
Native Americans and Early Settlers

LESSON PREVIEW

LAUNCH Cycle Phase(s): Phase 3: Navigate Ideas
Lesson Topic: Ideate, Brainstorm on Problem
Grade: 3
Estimated Time: 40 mins.

Objectives:

- Empathize with historic people, Native Americans and early settlers, evaluating motivations, impact, and perspectives
- Demonstrate the ability to make inferences based on background knowledge and newly acquired knowledge
- Develop research skills individually and collaboratively
- Define a needs statement for the issue

Standards:

California History Social Studies

- 3.2 Students describe the American Indian nations in their local region long ago and in the recent past.
- 3.2.1 Describe national identities, religious beliefs, customs, and various folklore traditions.
- 3.2.2 Discuss the ways in which physical geography, including climate, influenced how the local Indian nations adapted to their natural environment (e.g., how they obtained food, clothing, tools).
- 3.2.4 4. Discuss the interaction of new settlers with the already established Indians of the region.
- 3.3.1. Research the explorers who visited here, the newcomers who settled here, and the people who continue to come to the region, including their cultural and religious traditions and contributions.

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- CCSS.ELA-LITERACY.L.3.3. Use knowledge of language and its conventions when writing, speaking, reading, or listening.

Next Generation Science Standards (NGSS)

- MS-ETS1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

International Society for Technology in Education (ISTE)

- 4C. Students develop, test and refine prototypes as part of a cyclical design process.

Vocabulary:

- Venn Diagram: a graph that helps you organize data, to show the similarities and differences between two objects.
- Need: something that is necessary or required to live (in this context).
- Needs statement: provides a clear explanation of an issue that is presented.

LESSON PREPARATION

Materials:

- All Notes from Lessons 1, 2, and 3 placed into Group packets
- Bios sheets
- Student Research sheets
- Student Press Conference sheet
- Student Press Conference Top Four sheet

- Venn Diagram sheet
- Sticky notes
- Cardboard for ideating/placing sticky notes

Tasks:

- Write needs statement (from last lesson) on white board

LESSON OUTLINE

Activity 1: Introduction to Navigating Ideas Phase (10 mins.)

- In their groups of four, excuse students to Learning Center area on the rug.
- Remind students that over the last few activities they learned about the needs of Chief Chowig and Gaspar de Portola and their people. Last week they defined the needs statement...write needs statement on board.
- Give students the challenge that they will need to design a space where Chief Chowig and Gaspar de Portola (and their people) can live together peacefully. Help students understand that they understand the needs of each group…now they need to develop a plan or design the details of the space.
- Explain to students today's activity:
- groups will receive their packets with research notes, sticky notes, and a piece of cardboard. Students should write (or draw) ideas for their design on sticky notes and place them on the cardboard. Students should discuss with their groups their design ideas. They will ultimately choose one idea (or a combination of a few) to develop a model in next week's lesson.
- Remind students a few important notes about brainstorming: it's important to listen to everyone's ideas in the group, try to think outside of the box/be creative, there isn't a right/wrong, try to list as many ideas as possible, then organize them, etc.
- Model the activity for students. A think aloud may be helpful…ex: "Okay, I'm going to remind myself what some of the needs are for these groups. (Review the Venn Diagram.) Okay, so I notice that it is important to Chief Chowig and his people want to keep their culture...so I would try and think of a good idea about how they could do that while also allowing the Europeans to practice their religion. So I would think about how I could design that type of living space and write that idea on a sticky note…"

Activity 2: Navigate Ideas (30 mins.)

- Distribute group packets, sticky notes, and cardboard (see instructions above).
- Students should have about 15 minutes writing and sharing ideas amongst their groups. Groups will need to have chosen one idea (or a combination of a few) by the end of today's activity. Have groups place a star on that stick note(s).
- Wrap up the activity by explaining to students next week they will be building models of their ideas with different types of materials.

DESIGN CHALLENGE: Designing a Shared Space for
Native Americans and Early Settlers

LESSON PREVIEW

LAUNCH Cycle Phase(s): Phase 5: Create a Prototype, Phase 6: Highlight and Fix
Lesson Topic: Build and iterate on the product
Grade: 3
Estimated Time: 45 mins.- 1 hour
Objectives:

- Empathize with historic people, Native Americans and early settlers, evaluating motivations, impact, and perspectives
- Demonstrate the ability to make inferences based on background knowledge and newly acquired knowledge
- Develop research skills individually and collaboratively
- Build and iterate on a product based on idea generation

Standards:
California History Social Studies

- 3.2 Students describe the American Indian nations in their local region long ago and in the recent past.
- 3.2.1 Describe national identities, religious beliefs, customs, and various folklore traditions.
- 3.2.2 Discuss the ways in which physical geography, including climate, influenced how the local Indian nations adapted to their natural environment (e.g., how they obtained food, clothing, tools).
- 3.2.4 4. Discuss the interaction of new settlers with the already established Indians of the region.
- 3.3.1. Research the explorers who visited here, the newcomers who settled here, and the people who continue to come to the region, including their cultural and religious traditions and contributions.

Common Core State Standards English Language Arts (CCSS)

- CCSS.ELA-LITERACY.W.3.8. Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.
- CCSS.ELA-LITERACY.SL.3.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 3 topics and texts*, building on others' ideas and expressing their own clearly.
- CCSS.ELA-LITERACY.SL.3.3. Ask and answer questions about information from a speaker, offering appropriate elaboration and detail.
- CCSS.ELA-LITERACY.L.3.3. Use knowledge of language and its conventions when writing, speaking, reading, or listening.

Next Generation Science Standards (NGSS)

- MS-ETS1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

International Society for Technology in Education (ISTE)

- 4C. Students develop, test and refine prototypes as part of a cyclical design process.

Vocabulary:

- prototype: a first model of something, a draft of an idea

<u>LESSON PREPARATION</u>

Materials:

- All Notes from Lessons 1, 2, and 3 placed into Group packets
- Bios sheets
- Student Research sheets
- Student Press Conference sheet
- Student Press Conference Top Four sheet
- Venn Diagram sheet
- Group brainstorming board with sticky notes from previous lesson
- Large pieces of white paper (one per group)

- Markers, colored pencils, crayons, etc.
- Images of maps (optional)

LESSON OUTLINE

Activity 1: Introduction to Prototyping and Iterating (10 mins.)

- In their groups of four, excuse students to Learning Center area on the rug.
- Remind students about what they completed in the previous lesson, i.e. navigated ideas for their prototype
- Remind students that their challenge is to design a space for Chief Chowig and Gaspar de Portola to live together peacefully.
- Explain students today's activity:
- Groups will receive their packets with research notes and the brainstorming boards from last week. Today, their task is to physically draw a map applying the ideas they brainstormed last week. (This may be a good opportunity to help students understand what a map may look like…). Groups will have XX amount of time to draw their maps (IN PENCIL), then Chief Chowig and Gaspar de Portola will walk around to meet with the groups. When it's time to meet with the groups, students should be prepared to present their map and defend decisions they made on the map. Chief and Gaspar de Portola will provide feedback, in which students should decide how they'd like to apply. After each group meets with the chief and Gaspar, they should work on making modifications and finalizing their map (i.e. add color, etc.). .

Activity 2: Prototyping and Iterating (50 mins.)

- Students will work in groups to build a prototype in the format of a map (directions above).
- Chief Chowig and Gaspar de Portola will meet with students after XX amount of time. Here are some suggested guidelines for the feedback session:
- Ask students to defend the decisions they made in designing their spaces.
- Do they accommodate the needs of both Gaspar de Portola and Chief Chowig?
- Are both parties appeased enough to live there?
- Do the spaces and ideas thoughtfully consider the two cultures?

- Are the culture, beliefs, languages, motivations, and living styles thoughtfully considered?
- Groups should apply feedback into their prototypes and work on making a finished product. Students should be ready to present their maps to the class tomorrow.

DESIGN CHALLENGE: Designing a Shared Space for
Native Americans and Early Settlers

LESSON PREVIEW

LAUNCH Cycle Phase(s): Phase 7: Launch
Lesson Topic: Share maps with the class
Grade: 3
Estimated Time: 45 mins.
Objectives:

- Empathize with historic people, Native Americans and early settlers, evaluating motivations, impact, and perspectives
- Demonstrate the ability to make inferences based on background knowledge and newly acquired knowledge
- Develop research skills individually and collaboratively
- Share product with an audience

Standards:
California History Social Studies

- 3.2 Students describe the American Indian nations in their local region long ago and in the recent past.
- 3.2.1 Describe national identities, religious beliefs, customs, and various folklore traditions.
- 3.2.2 Discuss the ways in which physical geography, including climate, influenced how the local Indian nations adapted to their natural environment (e.g., how they obtained food, clothing, tools).
- 3.2.4 4. Discuss the interaction of new settlers with the already established Indians of the region.
- 3.3.1. Research the explorers who visited here, the newcomers who settled here, and the people who continue to come to the region, including their cultural and religious traditions and contributions.

Common Core State Standards English Language Arts (CCSS)

- CCSS.ELA-LITERACY.W.3.8. Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.
- CCSS.ELA-LITERACY.SL.3.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 3 topics and texts*, building on others' ideas and expressing their own clearly.
- CCSS.ELA-LITERACY.SL.3.3. Ask and answer questions about information from a speaker, offering appropriate elaboration and detail.
- CCSS.ELA-LITERACY.L.3.3. Use knowledge of language and its conventions when writing, speaking, reading, or listening.

Next Generation Science Standards (NGSS)

- MS-ETS1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

International Society for Technology in Education (ISTE)

- 4C. Students develop, test and refine prototypes as part of a cyclical design process.

Vocabulary:

- NA

LESSON PREPARATION

Materials:

- Completed prototype

LESSON OUTLINE

Activity 1: Introduction to sharing prototypes (maps) (5 mins.)

- In their groups of four, excuse students to Learning Center area on the rug.
- Tell students that today they will be sharing their prototypes (maps) with the class. Groups should follow these guidelines for the presentations:
- Introduce yourselves to the class

- Take turns explaining what was drawn on the map and WHY those decisions were made (i.e. why did you include a body of water and in this location?)
- Explain to class how each culture was thoughtfully considered.

Activity 2: Present prototypes (maps) (40 mins.)

- Excuse students to prepare with their groups. Give them XX amount of time to decide on who is explaining what on their maps.
- Once students are ready, direct students to sit at the learning area in their groups. Call on groups to share with prototypes with the class. Explain that students will have XX minutes to share with prototypes with the class. (Consider allowing students to ask questions, depending on time.)

APPENDIX E

Field Notes Template

Study Field Notes - Kristin Van Gompel

Reflection, Observation, Interview

Date/Class/ Lesson	Field Note Type	Notes
		•

APPENDIX F

Four Cs Checklists

Four Cs Checklist: Collaboration
Grade 3

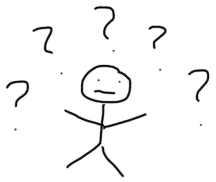
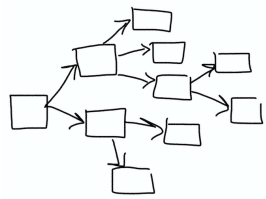
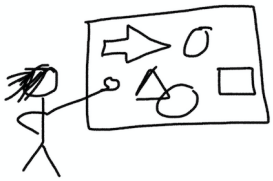
Name: _____
Date: _____

Directions: Read each box, think about how you are doing, and add a check mark to that box. ☑

How am I doing?		NOT YET	STARTING TO	YES
 Collaborate with Different Groups	I can work well with different people and groups.	☐	☐	☐
 Be Flexible and Compromise	I can be flexible, and I am willing to agree with my group so we can make decisions together.	☐	☐	☐
 Share Responsibility in a Group	I can share responsibility for work with my group. I value ideas from each group member.	☐	☐	☐

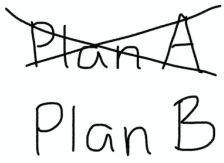
Four Cs Checklist: Critical Thinking Name: _____
Grade 3 Date: _____

Directions: Read each box, think about how you are doing, and add a check mark to that box. ☑

How am I doing?		NOT YET	STARTING TO	YES
 Reason Effectively	I can make different types of decisions (decisions based on facts and based on experiences).	☐	☐	☐
 Use Systems Thinking	I can think about how different things impact each other and how they work together.	☐	☐	☐
 Make Judgments and Decisions	I can think about other people's points of view. I can make connections between information. I can reflect on learning experiences and how I arrived to my conclusion.	☐	☐	☐
 Solve Problems	I can solve problems in regular and new ways. I can ask good questions to understand different points of view.	☐	☐	☐

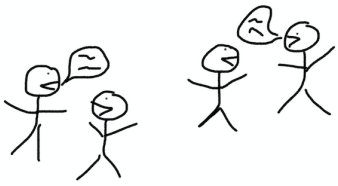
Four Cs Checklist: Creativity Name: _____
Grade 3 Date: _____

Directions: Read each box, think about how you are doing, and add a check mark to that box. ☑

How am I doing?		NOT YET	STARTING TO	YES
 Think Creatively	I can use strategies to make new ideas (like brainstorming or drawing). I can create new ideas and improve my ideas.	☐	☐	☐
 Work Creatively with Others	I can communicate new ideas to other people. I can be open to ideas from other people.	☐	☐	☐
 See Failure as Learning Opportunities	I know that when I don't do something right it is an opportunity to learn. I understand that sometimes creativity is a long process of learning from mistakes.	☐	☐	☐
 Implement Innovations	I can bring creative ideas to life. I can turn my ideas into products that could help people.	☐	☐	☐

Four Cs Checklist: Communication Name: _____
Grade 3 Date: _____

Directions: Read each box, think about how you are doing, and add a check mark to that box. ☑

How am I doing?		NOT YET	STARTING TO	YES
 Communicate Thoughts	I can communicate my thoughts and ideas to talking to people or writing my ideas.	☐	☐	☐
 Listen Effectively	I can listen to figure out the meaning of something, like information or ideas someone is sharing.	☐	☐	☐
 Use Media and Technology	I can use different types of technology for my projects.	☐	☐	☐
 Communicate in Diverse Environments for Different Purposes	I can communicate in different environments and for different reasons (like telling an idea, or motivating someone).	☐	☐	☐

APPENDIX G

Student Self-Reflection

Individual Self-Reflection Questions

Name: _____

Grade 3 Date: _____

Directions: Answer each question as honestly as possible.

1. What did you learn from this experience? Would you want to do this again?

2. How well did you work with your group?

3. What were some creative risks that you took?

4. Which phase in the LAUNCH Cycle was the best for you and why?

APPENDIX H

Student Interview Protocol

Date/Time:

Location:

Class/Lesson:

Interviewer:

Interviewees:

Instructions: The interviewer will ask the following questions to initiate a conversation. Probing questions will be asked in no particular order.

Questions:

1) Can you tell me about the activity you completed today?
2) What did you like or dislike about the activity?
3) Did you learn anything from today's activity?

For probing:

- Can you tell me a little more about…
- Can you give me an example…
- Why did you decide to…
- What exactly do you mean by…

APPENDIX I

Teacher Self-Reflection

Name:

Date:

1. How would you currently define 21st century learning?

2. How would you currently define design thinking?

APPENDIX J

Teacher Interview Protocol

Date/Time:

Location:

Class/Lesson:

Interviewer:

Interviewee:

Instructions: The interviewer will ask the following questions to initiate a conversation. Probing questions will be asked in no particular order.

Questions:

1. Can you describe the design thinking phase implemented in the classroom today?
2. What did you notice about students during the lesson?
3. How would you describe skills such as critical thinking, communication, collaboration or creativity were exercised by students?
4. Can you anticipate any challenges for further implementing design thinking activities?

For probing:

- Can you tell me a little more about…
- Can you give me an example…
- Why did you decide to…
- What exactly do you mean by…

APPENDIX K

Graduate School of Education and Psychology IRB Letter of Approval

PEPPERDINE

Pepperdine University
24255 Pacific Coast Highway
Malibu, CA 90263
TEL: 310-506-4000

NOTICE OF APPROVAL FOR HUMAN RESEARCH

Date: August 15, 2018

Protocol Investigator Name: Kristin Van Gompel

Protocol #: 18-06-823

Project Title: Cultivating Twenty-first Century Skills: An Exploratory Case Study of Design Thinking as a Pedagogical Strategy in Elementary Classrooms

School: Graduate School of Education and Psychology

Dear Kristin Van Gompel:

Thank you for submitting your application for exempt review to Pepperdine University's Institutional Review Board (IRB). We appreciate the work you have done on your proposal. The IRB has reviewed your submitted IRB application and all ancillary materials. Upon review, the IRB has determined that the above entitled project meets the requirements for exemption under the federal regulations 45 CFR 46.101 that govern the protections of human subjects.

Your research must be conducted according to the proposal that was submitted to the IRB. If changes to the approved protocol occur, a revised protocol must be reviewed and approved by the IRB before implementation. For any proposed changes in your research protocol, please submit an amendment to the IRB. Since your study falls under exemption, there is no requirement for continuing IRB review of your project. Please be aware that changes to your protocol may prevent the research from qualifying for exemption from 45 CFR 46.101 and require submission of a new IRB application or other materials to the IRB.

A goal of the IRB is to prevent negative occurrences during any research study. However, despite the best intent, unforeseen circumstances or events may arise during the research. If an unexpected situation or adverse event happens during your investigation, please notify the IRB as soon as possible. We will ask for a complete written explanation of the event and your written response. Other actions also may be required depending on the nature of the event. Details regarding the timeframe in which adverse events must be reported to the IRB and documenting the adverse event can be found in the *Pepperdine University Protection of Human Participants in Research: Policies and Procedures Manual* at community.pepperdine.edu/irb.

Please refer to the protocol number denoted above in all communication or correspondence related to your application and this approval. Should you have additional questions or require clarification of the contents of this letter, please contact the IRB Office. On behalf of the IRB, I wish you success in this scholarly pursuit.

Sincerely,

Judy Ho, Ph.D., IRB Chair

APPENDIX L

Student Post Self-Assessment: Four Cs

Question	**Yes**		**Starting to**		**Not Yet**	
Collaboration	*n*	%	*n*	%	*n*	%
• I can work well with different people and groups.	17	77%	5	23%	0	0%
• I can be flexible, and I am willing to agree with my group so we can make decisions together.	18	82%	3	14%	1	4%
• I can share responsibility for work with my group. I value ideas from each group member.	16	73%	6	27%	0	0%
Communication						
• I can communicate my thoughts and ideas to talking to people or writing my ideas.	15	68%	5	23%	2	9%
• I can listen to figure out the meaning of something, like information or ideas someone is sharing.	15	68%	7	32%	0	0%
• I can use different types of technology for my projects.	14	64%	8	36%	0	0%
• I can communicate in different environments and for different reasons (like telling an idea, or motivating someone).	18	82%	2	9%	2	9%
Creativity						
• I can use strategies to make new ideas (like brainstorming or drawing). I can create new ideas and improve my ideas.	18	82%	4	18%	0	0%
• I can communicate new ideas to other people. I can be open to ideas from other people.	9	41%	12	55%	1	4%
• I know that when I don't do something right it is an opportunity to learn. I understand that sometimes creativity is a long process of learning from mistakes.	18	82%	3	14%	1	4%
• I can bring creative ideas to life. I can turn my ideas into products that could help people.	13	59%	6	27%	3	14%
Critical Thinking						
• I can make different types of decisions (decisions based on facts and based on experiences).	11	50%	9	41%	2	9%
• I can think about how different things impact each other and how they work together.	9	41%	11	50%	2	9%
• I can think about other people's points of view. I can make connections between information. I can reflect on learning experiences and how I arrived to my conclusion.	13	59%	7	32%	2	9%
• I can solve problems in regular and new ways. I can ask good questions to understand different points of view.	15	68%	7	32%	0	0%