THE DEVELOPMENT OF PRACTICE FIELDS FOR RAPID INTERDISCIPLINARY DESIGN AND ENTREPRENEURIAL ACTIVITY

by

GREGORY WILSON

(Under the Direction of Lloyd Rieber)

ABSTRACT

Professionals from business, science, technology, engineering, art, and math-related fields use design activities to solve the complex problems of modern society. As students, they need access to activities that provide the opportunity to engage in an authentic setting. Extracurricular experiences are useful for developing a practice field for students to participate in the types of activities they will encounter in a workplace. Rapid design activities are one type of extracurricular experience that fosters a community of innovation among students. As with any learning intervention, students in these practice fields need the proper framework to be successful.

This dissertation explores the expansion of the community of innovation framework (West, 2009) to develop an informal rapid design practice field based on situated learning principles. An educational design research methodology was used to investigate how this framework can be used to develop a rapid design learning environment. Two iterative cycles of research, design, implementation, analysis, and redesign were conducted over a two-year period. The pilot study found that the practice field taught students design and entrepreneurship concepts that they would not have otherwise learned in their studies, altered their view of their own and other disciplines, and gave them the confidence to work on new and old business ideas after the event. The second study investigated in-depth the development of communities of innovation during a rapid design event. Three teams serve as case studies to report details on communities of innovation formation, development, and progression during rapid design events. The second study found that the event led participants through three phases of a community of innovation: community formation, project development, and project presentation and continuation. While participating in the community, students encountered many problems, including time constrains, technical challenges, loss of team members, and missing expertise. To overcome these challenges, teams often looked for help from members of the larger community, including mentors, instructors, and other teams. Overall, seven design principles and 21 implementation strategies were developed as a guide for practitioners to develop these environments with the goal of cultivating the necessary skillsets and mindsets for innovation.

INDEX WORDS: Design thinking education, Entrepreneurship education, Informal learning, Challenge-based learning, Interdisciplinary collaboration, Community of innovation, Educational design research, Innovation, Situated-based learning, Practice fields

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by

GREGORY WILSON

B.S., Georgia Institute of Technology, 2007

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GREGORY WILSON

Major Professor: Lloyd P. Rieber
Committee: Ikeson Choi
Theodore J. Kopcha
John Mativo

Electronic Version Approved:

Suzanne Barbour
Dean of the Graduate School
The University of Georgia
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DEDICATION

This dissertation is dedicated to my wife, Ashley, who has supported and encouraged me throughout my college journey that started 12 years ago. She also carried the role of primary caretaker of our children, Hanan and August-Gregory, while I completed my doctoral work. This dissertation is also dedicated to my parents, Cynthia and Gregory, who instilled in me from a very early age that I could accomplish anything.

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CHAPTER 1

INTRODUCTION

Background

Professionals in fields related to science, technology, engineering, art, math, and business are considered members of the growing creative class in the United States. This group of professionals, which makes up nearly one-third of the workforce in the United States, are needed to create new solutions to solve society's toughest problems (Florida, 2012). Once students choose to enter these fields in college, educators have the challenge of preparing them to succeed in the 21st century workplace. Results from a national survey of a 155 employers found that the top five skills they believe are needed for job success include oral and written communication, collaboration, professionalism, and problem solving (Lichtenberg, Woock, & Wright, 2008). These results suggest that employers expect college graduates to demonstrate mastery of their craft and competency in a diverse area of general knowledge. Evers, Rush, and Berdrow (1998) propose that self-regulation, leadership, and an innovation mindset are basic competencies college graduates need to master. The combination of these skills, often called *21st century skills*, are considered as equally important to employers as technical skills (*The PreparedU Project: An In-depth Look at Millennial Preparedness for Today's Workforce*, 2014). Many college graduates who enter the workforce report that they are not properly prepared to use these essential 21st century skills (Baytiyeh, 2012). Some researchers suggest that this lack of preparation is caused by a disconnect between skills developed in college and those needed in today's workforce (Evers et al., 1998).

Employers from the creative class fields expect college graduates to engage in innovation. Innovation is defined as a process to place new ideas into practice where creativity acts as a vital resource for generating a new idea (Thompson & Lordan, 1999). These new ideas are then developed into new products, services, or processes. Drucker (1985) proposes that the practice of innovation is determined by an organization's ability to take advantage of seven contextual sources when present including the unexpected, incongruities, process need, changes in industry and market structures, changes in demographics and perception, and new knowledge or a good idea. Many industries use some sort of innovation process with differing resources and techniques.

Students who develop mindsets that foster innovation are prepared to use *21st century skills*. Mindsets are beliefs that expand when concepts are seen in a new way (Dweck, 2006). Stephanie Marshall (2009) states that "it is the nature and quality of our thinking that shapes who we become, and who we become shapes the world" (p. 48). Mindsets that equip students to engage in the innovation process include the growth mindset, integrative thinking, and the opposable mind. A person with a growth mindset believes that anyone's knowledge and skills can grow with application and experience (Dweck, 2006). Individuals with this mindset often thrive on challenges and take charge of their learning. People who demonstrate integrative thinking have a broad view of what is important, and welcome disorder in problem solving (Martin, 2007). They are able to keep the big picture in mind while working on specific parts of a problem. A person demonstrates an opposable mind when he or she uses the tension from holding two conflicting ideas to generate a new innovative idea (Martin, 2007). It is important for students to obtain these mindsets, as they are necessary to succeed in the rapid, flexible, interdisciplinary teams they will encounter in the workplace.

Growth mindsets, integrative thinking, and opposable minds can be developed through exposure to design thinking, which introduces students to new problem solving approaches to tackle complex challenges (Goldman et al., 2012). Design thinking is the intersection of usability (will people use it?), feasibility (can it be built with current technology?), and viability (can a business be built from it?) when creating a new innovation (Brown, 2013). It allows problem solvers to take a human-centered approach by equipping them with the designer's toolkit. Design thinking drives innovation and creative confidence, and can increase student engagement throughout their academic career (Sheppard, Macatangay, Colby, & Sullivan, 2008). While design thinking is normally associated with designers and business professionals, engineers have also become major contributors (Sutton, 2010).

One of the most popular design thinking methods is the five-step process created by Stanford's design school known as the d school. This iterative process consists of developing empathy for potential users, defining a point of view for the problem being solved, brainstorming potential solutions, and prototyping and testing the best possible solution ("d. school bootcamp bootleg," n.d.). Design thinking primarily involves developing empathy through field work, testing new ideas, demonstrating solutions and working on teams that expand across disciplines (Royalty, Oishi, & Roth, 2012). Razzouk and Shute (2012) state that improving students' design thinking and ability to use a designer's processes and methods will prepare them to create innovative solutions for complex problems. Design thinking is important for creative class professionals to learn because while technologies and processes will change over time, design thinking will always be useful as a result of its use of 21st century skills such as collaboration, communication, creativity, and critical thinking.

Professionals who possess a depth of knowledge in one skill and the broad spectrum of mindsets for innovation are known as being T-shaped. Tranquillo (2013b) provides an extensive history of the concept of the T-shaped individual. The term has been used as far back as the early 1990s, but was made popular by Tim Brown, CEO of famous design firm IDEO (Hansen, 2010). John Dewey (1933) first alluded to the T-shaped concept when he proposed two types of learning: learning about the subject, and learning to become a professional practitioner. The "T" represents a visual metaphor to describe characteristics people should possess. The vertical line of the "T" represents the depth of skill needed to contribute to developing a solution. The primary focus of higher education is college professors teaching these types of skills. The horizontal line of the "T" represents the ability to collaborate across disciplines. Advocates suggest that these abilities also include empathy, the ability to view a problem from a different perspective, an enthusiasm for interacting with other disciplines, and a desire to learn their skills (Hansen, 2010). Professionals who possess these skills can adapt faster to complex situations and role changes, and can use better communication skills in diverse scenarios (Donofrio, Spohrer, & Zadeh, 2009).

Figure 1 displays how students are developed into T-shaped professionals through exposure to design activities. Students who participate in design thinking activities combine their disciplinary skills with 21st century mindsets and skillsets to develop into T-shaped professionals who can engage in the innovation process.

College graduates who are "T-shaped" are more desirable in the workforce. The Hart Research Associates (2013) conducted an online survey of 318 employers from organizations with 25 or more employees. A total of 95% of employers surveyed responded that they prefer to hire college graduates who can utilize innovative thinking.

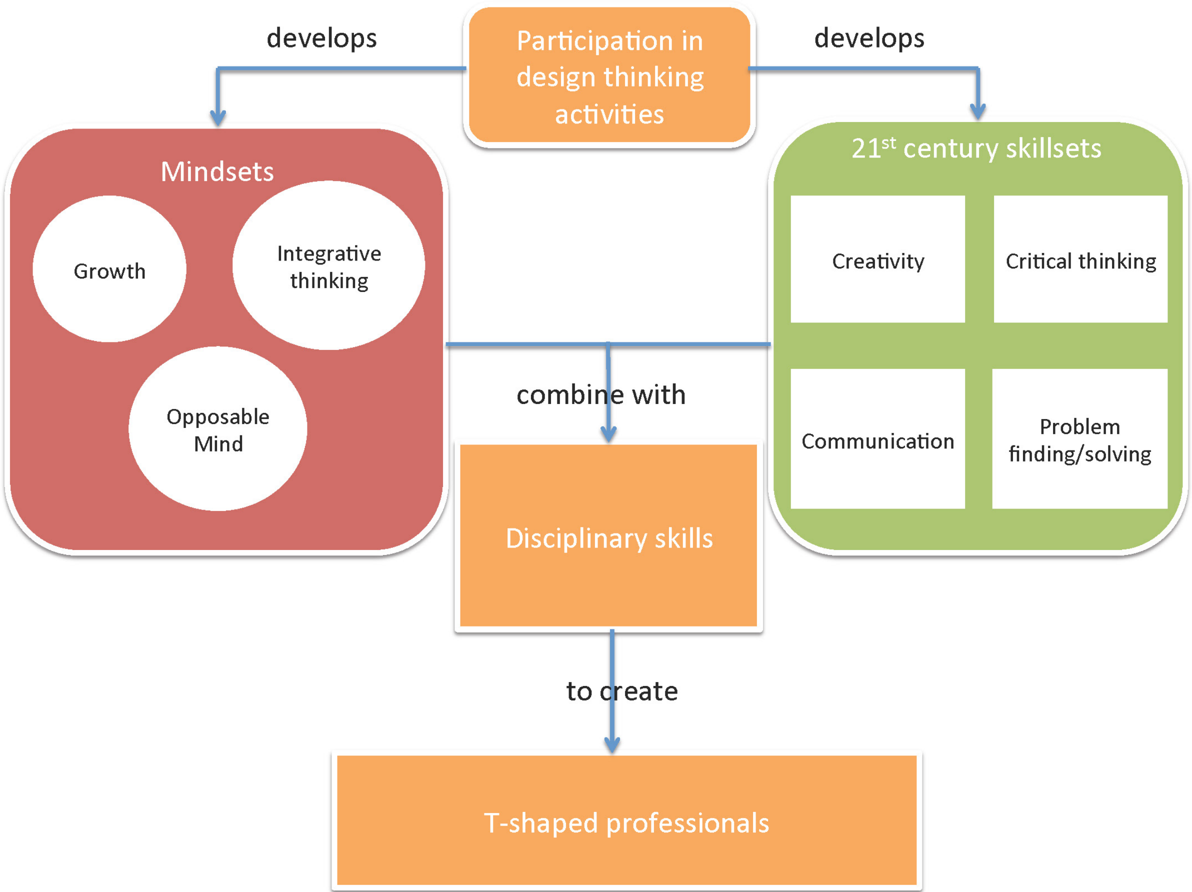


Figure 1. Graphic visualizing T-shaped professionals development through design thinking exposure.

The survey also found that nearly all employers believe that a combination of field-specific skills and a broad range of knowledge are important for long-term career success, and that possession of these broad skills are actually more important than acquiring a depth of skills in college. In creative class industries, many product development teams vary in duration with changing participants and goals while involving professionals from various backgrounds including engineering, design, and business. Companies are experimenting with new processes for discovering new marketable ideas through immersive collaborative innovation development. Over the years, these interdisciplinary and collaborative structures have had many names including extreme collaboration, radical collocation, deep dives, and rapid design labs (Nieters, 2012; Teasley, Arbor, & Olson, 2000). Strotmeyer (2010) states that these processes "create the space for organizations to practice experimentation, collaborate and discover insights, and apply their ideas to their most pressing business challenges" (para. 11). Within these environments, participants from various disciplines are co-located and work together on a project by cohabiting in one room for the entirety of the collaboration. The co-location fosters immersive collaboration through rapid communication, and spontaneous meetings and interactions (Takeuchi & Nonaka, 1986). Teams involved in co-located collaboration are usually temporary. Uzzi and Spiro (2005) used Broadway performers to show that temporary teams can perform at a higher level than teams that have been together longer. Edmondson (2011) describes a process called teaming, which consists of a temporary group of experts solving problems that are complex, and can change rapidly. Teaming is often found in companies investigating new ventures and early-stage startups. To facilitate successful teaming experiences, advocates recommend scoping out the challenge, structuring around the boundaries of the project, and sorting tasks among the team. In short-term collaboration, members of the team must quickly trust one another and discover a process for working together. Edmondson (2011) recommends structuring teaming activities by emphasizing purpose, promoting a safe space where disagreement and learning from failure is encouraged, and conflicts are used to make the team better. Burkus (2013) proposes that implementation of temporary teams can eventually form a loose network of creative professionals who can be joined around several projects at one time.

Team cohesion in rapid design settings is critical to project success. Design teams have to manage obstacles such as group cohesion, proper engagement in autonomy and productivity, openness to all perspectives, and maintaining big picture thinking (Rogers, 2012). People who function in rapidly changing environments must learn to navigate in situations in which they are at the edges of their existing knowledge (Bransford, 2007). Creative class professionals will encounter complex, uncertain workplaces with random occurrences that require quickly changing course of action. Each project will be different and professionals must learn new topics often. Participants of a rapid design team will need to use adaptive expertise to apply their knowledge to new contexts and situations (Wineburg, 1998).

To become properly prepared to encounter these rapid design environments, students should participate in repeated practice of critical or immersive experience simulating real-world situations (Marshall, 2009; Zoltowski, Oakes, & Cardella, 2012). Situated learning theory (also called situativity theory) offers the proper guidance to develop learning environments that prepare students for these rapid design contexts. Through the situated learning perspective, knowledge is considered "distributed among people and their environment, including the objects, artifacts, tools, books and the communities they are part of" (Greeno, Collins, & Resnick, 1996, p. 20). The primary purpose of situated learning is to prepare students for future tasks. Activities that make use of situated learning theory contain cultural and personal significance that engage students in meaningful practice (Newstetter & Svinicki, 2014). Self-reflections and portfolios of work are used to assess learning gains in situated activities (Newstetter & Svinicki, 2014).

In traditional learning environments, students are tasked with responding to instructions in a project brief. However, in situated learning environments, students solve problems in a real-world context using the setting to learn relevant information about the problem, and create new solutions (Davis, 2011). Problem solving in a real-world context is an essential skill for college graduates to develop before they engage in the innovation process as professionals.

Statement of the Problem

While the benefits of student involvement in activities that promote rapid design and the opportunity to collaborate across disciplines are numerous, universities have been slow to offer immersive situated design thinking experiences. Many universities offer discipline-specific senior capstone classes through the engineering department to design new products. This practice is limiting because it does not provide the opportunity for students to collaborate across disciplines, and students do not experience design activity until late in their academic career.

Many barriers to implementing interdisciplinary design classes exist due to factors such as low enrollment, lack of administrative support, and inadequate design of the curriculum (Goodman & Huckfeldt, 2013). To better prepare students to tackle society's complex problems and be efficient members of today's workforce, it is necessary for universities to overcome these barriers and develop opportunities for students to engage in the interdisciplinary design process. Informal learning environments are not affected by many of the aforementioned barriers making them a viable option for engaging students in design thinking. Participation in activities beyond the classroom can be very beneficial to students. Learning in multiple contexts help students create a more flexible understanding of abstract concepts, increasing ease of use in new contexts (Gick & Holyoak, 1983). Extra- and co-curricular activities such as co-ops, internships, clubs, and events help students connect classroom learning to a real-world context and break down silos between departments and organizations (Kuh, 1994). Despite the freedom that informal learning environments provide, a comprehensive framework and design principles are needed to guide practitioners and maximize student outcomes.

Purpose of the Study

The purpose of this study was to use the educational design research process to develop an informal rapid design activity environment to prepare students entering fields involved with innovation development for the type of context they will encounter in the workplace. The study also investigated how communities of innovation develop within this environment. Educational design research is defined as "the iterative development of solutions to practical and complex educational problems [that] yields theoretical understanding that can inform the work of others" (McKenney & Reeves, 2012, p. 7). This study involved the process of developing multiple iterations of a rapid design practice field and testing its effectiveness in engaging students in interdisciplinary situated design.

Research Questions and Methods

This educational design research was guided primarily by the following overarching research question:

- What design principles can be derived from the development of an informal design and entrepreneurship event?

The pilot study (first iteration) presented in this research contained two additional sub-questions:

- What attributes of the practice field do students find engaging?
- How can the practice field support the continuation of projects beyond the event?

Results from the pilot study then informed three new research sub-questions during the second iteration.

- How can communities of innovation form during rapid situated design activities?
- How can just-in-time learning tools facilitate innovation scaffolding in these communities?

- How can participants in these communities overcome challenges?

More information about the methodology of this study can be found in chapter 3.

Rationale and Significance

Discovering the attributes that make rapid design environments successful in providing an authentic professional design experience can assist in its implementation in diverse contexts. Insights into the features, functions, and interactions of the environment will act as design principles and guidelines for developing new rapid design environments. This study seeks to investigate how a rapid design practice field can prepare students entering fields involved with innovation development for the type of context they may encounter in the workplace, as they work towards becoming T-shaped professionals.

Students who engage in interdisciplinary collaboration during a rapid design practice field form a community of innovation where the only purpose is to develop an innovation in the time that the team is together. It is necessary to discover how these communities form and progress throughout the event, and how the scaffolds for learning design and entrepreneurship support the communities. Students who form collaborations to tackle design and entrepreneurship challenges will encounter many obstacles to success. They must quickly develop cohesion, make tough decisions, overcome conflicts, and fill in knowledge gaps. These obstacles are especially likely to arise in interdisciplinary settings. Conflicts in interdisciplinary teams can emerge from differences in terminology, lack of respect for other disciplines, and differing motivations and goals (McNair, Newswander, Boden, & Borrego, 2011). If not managed properly, these obstacles can lead to a team's failure to achieve its goals. It is necessary for students to learn how to navigate these challenges, because they will often encounter similar scenarios in their workplace. While it is commonly known that students experience obstacles participating in groups, not many studies offer a detailed analysis on how students internalize these experiences. Also, students from various disciplines may experience these situations differently, offering further insight into why interdisciplinary collaboration is difficult. Understanding students' experiences can help researchers understand how they handle these situations. Findings from student experiences can also be useful for developing strategies to assist students in overcoming these obstacles.

CHAPTER 2
REVIEW OF THE LITERATURE

Introduction

According to some researchers, professionals will have to develop new skillsets and mindsets to tackle the 21st century's toughest problems (Gardner, 2006; Pink, 2006; Thomas & Brown, 2011). Instructors will need to facilitate complex and immersive instructional activities to assist students in developing these competencies. This chapter is divided into two major sections. The first section will discuss the benefits of using informal learning environments in higher education, the influence of experiential learning on these environments, and the types of informal environments used for engaging students in innovation. The second section will discuss the design thinking and entrepreneurship processes and why they are important to innovation, the role of situated learning in fostering authentic design and entrepreneurial experiences for students, the introduction of situated practice fields for engaging students in authentic activities, examples of design practice fields found in higher education, and a conceptual framework for developing interdisciplinary rapid design practice fields.

Informal Learning Environments for Developing Innovation Mindsets

Students must have the opportunity to engage in the innovation process in authentic or semi-authentic settings to develop innovation mindsets. While learning in higher education settings is traditionally associated with classroom settings (e.g., lectures, textbooks, and homework), an opportunity exists to also utilize informal environments to promote authentic learning. Solving classroom problems does not adequately prepare students to develop the skills employers identify as important (Jonassen, 2014). Traditional classroom curriculum prepares students for the workplace by clearly stating the problem that needs solving and exploring only one clear solution. However, in real-world situations, problems are not readily presented, therefore students should have access to open, undefined, and ambiguous contexts to develop problem setting skills (Kotze & Purgathofer, 2009). Problem setting differs from problem solving because problem setting involves understanding the context of "problematic situations," and determining the parameters and constraints of the problem that needs to be solved (Schön, 1983).

Learning through authentic experiences is more effective and robust when "students have opportunities to use their knowledge and practice their skills in off-campus, real-world situations (e.g., co-ops, internships, service learning)" (Ambrose, 2013, p. 20). Because the aforementioned barriers present in traditional curriculum do not restrict informal environments, they are well suited for design thinking activities. The following sections will describe the experiential learning theory that influences informal learning, introduce the use of extra-curricular activities as informal activities in higher education, and discuss activities that are specifically used to increase innovation mindsets.

Learning through experience. Students develop employability skills through experience (Yorke, 2006) Experiential learning theory views learning as the process whereby knowledge is created through the transformation of experience (Dewey, 1938; Kolb, 1984). Kolb decomposes the process of learning into four phases: experiencing, reflecting, forming, and testing through an iterative foundation. Experiential learning activities include methods such as group interaction, brainstorming, guided imagination, and working with case studies. Instructors can engage students in deep learning by assisting students with accessing prior knowledge and connecting new information with old (Lattuca, Voigt, & Fath, 2004). Beckman and Barry (2007) discusses a generic innovation experiential model where students with different learning styles and diverse field studies can learn and contribute to the process. The first stage, “Observation” is the core of the innovation process. The analytical analysis of the problem context performed in this stage is critical for the remainder of the innovation process (Beckman & Barry, 2007). The “Frameworks” stage involves taking the data acquired from the previous stage and finding interesting tidbits and stories to find the needs for the observed population. In the “Imperatives” stage, the design team decides on the most important goals of the innovation process to focus on. The list of focused needs and design principles, called imperatives, are created to guide the design team during the remainder of the process. During the final stage, “Solutions”, the design team brainstorms ideas, choose the ones that are best associated with the imperatives, and begin building prototypes to test with users. In the innovation process, “identifying, framing, and reframing the problem to be solved are as important as solving the problem or finding an appropriate solution” (Beckman & Barry, 2007).

The authors highlight various learning styles that are suited for each stage of the innovation process based on Kolb’s experiential learning process. Students with a divergent learning style analysis concrete situations from different points of view. Students with an assimilating learning style excel at generating ideas and abstract concepts and can put information in organized, logical form. Students with a converging learning style excel at solving problems and finding practical uses for ideas and theories. Students with an accommodating learning style prosper from learning by doing activities and act on “gut” feelings. Accommodating learners just want to build something. Table 1 shows the connection between the learning styles, the stages of the innovation process where they are most effective, and the likely field of study for students with each learning style. This table supports the idea that everyone can have valuable contributions to the innovation process. Because each learning style is effective at certain stages, the authors recommend assigning roles in the team based on learning style and rotating leadership based on the current innovation stage.

Table 1.

Learning styles associated with each innovation process

Innovation Process Stage	**Learning Style**	**Mostly Likely Field of Study**
Observation	Divergent	Arts, English, History, Psychology
Frameworks	Assimilation	Math, Physical Sciences
Imperatives	Converging	Engineering, Medicine, Technology
Solutions	Accommodating	Engineering, Education, Communication, Nursing

Learning outside of the classroom. Because informal learning environments can more closely simulate real-world experiences, students can readily develop employability skills. Trinder et al. (2008, p. 13) defines informal learning as resulting from "daily social life activities related to education, work, socializing with others, or pursuit of leisure activities and hobbies." The Academic Competitiveness Council and the National Science Board recommended informal learning and higher education as two of the three components needed to keep the United States economy competitive (U.S. Department of Education, 2007). The National Research Council (2009) reports that informal learning is essential to increasing interest and appreciation of science, technology, engineering, and math (STEM). Informal learning accounts for over 75% of a person's total life-long learning (Cross, 2007). Undergraduate students spend less than eight percent of their time in formal classroom activities (Bell, 2009). These statistics show that a large amount of a student's learning occurs outside of the classroom. Informal experiential activities can also be used to help students' persist through college (Burt et al., 2011), increase students' ethical awareness (Burt, Carpenter, & Hol, 2013), and foster connections between concepts learned in the classroom and those experienced outside the classroom (Bass, 2012; Burt et al., 2013). Pascarella and Terenzini (2005) reported on the positive relationship with social and informal activities and cognitive skills, intellectual skills, ethical development, academic persistence, and career attainment. In contrast to the traditional classroom curriculum, learning outcomes from informal environments tend to be broad, unanticipated, and at different scales (National Research Council, 2009). Rogers (2012) outlines five recommendations for developing informal design learning environments including: 1.) taking a systems approach to designing environments to support creative work; 2.) introducing discrete practices to scaffold and differentiate idea generation and idea evaluation; 3) supporting artifact creation, documentation, and sharing; 4) encouraging team members to (sometimes) work alone; and 5) providing non-work spaces for informal communication.

Extracurricular activities in higher education. Informal learning environments in higher education are found primarily in extracurricular activities and events (ECAs). Participation in ECAs is not required and students do not receive credit towards their degree (Thompson, Clark, Walker, & Whyatt, 2013). ECAs increase student involvement and exploration by providing deeper connections with peers, faculty, and staff (Astin, 1984; Roberts, 1989; Tinto, 1975). ECAs can include hobbies, social groups, sporting, cultural or religious activities, and voluntary or paid work (Thompson et al., 2013). The National Survey of Student Engagement (2007) discovered more than half of college students surveyed spend at least one hour participating in ECAs. Wilson et al. (2013) found that institutional culture greatly affects the type and frequency of activities in which STEM students engage. Kuh (1994) outlines nine conditions for encouraging student to participate in out-of-class experiences: 1) clear, coherent, and consistently expressed educational purpose; 2) a guiding institutional philosophy that values talent development as a primary goal of undergraduate education; 3) complementary institutional polices and practices congruent with students' characteristics and needs; 4) high, clear expectations for student performance; 5) use of effective teaching approaches; 5) use of effective teaching approaches; 6) systematic assessment of student performance and institutional environments, policies, and practices; 7) ample opportunities for student involvement in meaningful out-class-activities; 8) human scale settings characterized by the ethics of membership and care; and 9) an ethos of learning that pervades all aspects of the institution (p. 3)

Many influences affect which ECAs students choose. A study conducted on 67 students found that students select ECAs based on enjoyment, to cope with stressful times, and to do something meaningful and valuable for the community, even if participation was difficult work and impacted academic study (Thompson et al., 2013). Students with the forethought to look ahead to post graduation choose ECAs valued by employers and that make them experts in their field, which provides students with increased job marketability (Roulin & Bangerter, 2013; Stevenson & Clegg, 2011).

Researchers in engineering education have begun studying the impact of extracurricular activities extensively. Chachra, Chen, Kilgore, and Sheppard (2009) found that women were more likely to be involved in engineering-related extracurricular activities. Women are also more likely to hold leadership positions in clubs and organizations, while men are more involved in hands-on design activities. These findings suggest that ECAs that combine opportunities for leadership with collaborative design challenges can be used to increase engagement of both genders in engineering and possibly other STEM fields as well. Fisher (2011) found that out of all various types of extracurricular activities, academic competitions, and activities involving project teams offered the most opportunities for developing innovation mindsets through the development of *21st century skills.* In another study, engineering students cited many ECAs when describing significant design experiences (Zoltowski et al., 2012). Goldman et al. (2014) found design thinking workshops, supplemental training, courses, or degree programs in over 60 universities and colleges. The Clark School of Engineering at the University of Maryland uses ECAs such as clubs, bootcamps, and business plan competitions to build an entrepreneurial culture, provide knowledge resources in entrepreneurship, and organize opportunities for venture formation (Barbe, Magids, & Thornton, 2003).

Students who participate in extracurricular design events are usually more motivated and passionate than students forced to work together in a design class (Khorbotly & Al-Olimat, 2010). This usually leads to a more enjoyable experience. During these events, students are able to network, and work on public speaking and writing skills increasing their confidence in their professional abilities (Khorbotly & Al-Olimat, 2010). In ECAs, students are able to network and work on public speaking and writing skills, increasing their confidence in their professional abilities (Khorbotly & Al-Olimat, 2010). Students also learn the value of global awareness, humanitarianism, and community service (Borg & Zitomer, 2008; Coyle, Jamieson, & Oakes, 2005).

The goal of these extra-curricular environments should be to engage students in a transformative learning experience. Mezirow (1991) defines transformative learning as:

> The process by which we transform our taken-for-granted frames of reference (meaning perspectives, habits of mind, mind-sets) to make them more inclusive, discriminating,

open, emotionally capable of change, and reflective so that they may generate beliefs and opinions that will prove more true or justified to guide action. (p. 8)

Participation in a transformative learning experience is also connected with increased student self-confidence.

While most research focuses on engagement in long-term extra curricular activities such as clubs, internships, and co-ops, this research project focused on the development of rapid activities that take place over one or two days. These activities require less of an extended commitment from students but engage them in an intense fully immersive design project. Many students cite strenuous workload for lack of long-term engagement in extracurricular organizations (Lee & Wilson, 2005). More research is needed on the effects of short-term extra curricular activities on student learning development.

The following section will describe the most common types of informal environments used to teach innovation:

Popup classes. A popup class is a temporary course lasting one to four days and students receive no credit for their participation. Popup classes at Stanford University are generally centered on a design challenge where students are led through the design thinking process to build a prototype to solve a relevant problem ("Take a d.school class," n.d.). Through interviews with popup class instructors (detailed in Chapter 3), the author discovered that students are willing to take these classes for no credit because they are interested in working with other students on a challenge and making a contribution, and going deeper in design. Instructors use the popup structure to gauge interest and try out classes before adding them to the curriculum. The Design for America chapter at Northwestern University offers three extracurricular studios of various lengths for learning design and leadership (Gerber, Olson, & Komarek, 2012).

Students who participated in these studios reported an increase in innovation self-efficacy due to hands on experiences completing innovation tasks, learning from peers and professionals, and regular feedback.

Hack-a-thon/Make-a-thon. A hack-a-thon is an event that fosters the opportunity for full immersion in creating a new product, experience, or business (Brown & Hammond, 2013). Hack-a-thons are usually run on evenings or weekends, outside of normal working hours and can range from one day to three days. Hack-a-thons typically include elements such as a purpose or challenge, pre-event preparations, a project pitch phase, mixing and recruiting phase, project development phase, project presentations, judging, and closing statements (Duhring, 2014). While hack-a-thons are rooted in the tech industry, they involve people with or without technical skills. Hack-a-thons are often strictly hands-on activities with no lectures on the design or entrepreneurship process. However, some partnering companies offer workshops during the event on how to use their technology. Hack-a-thons are organized in spaces that allow for both individual and team activities. Organizers and mentors take on the role of responding to emergencies, and offering guidance (Duhring, 2014). IDEO developed the concept of a “make-a-thon” which is a hack-a-thon that is more design-driven and centered on collaboration across silos (Zhang, 2012).

Bootcamps. Bootcamps are more immersive and a longer duration than popup classes and make-a-thons. Bootcamps are centered on collaborating with others to learn new skills and tackle challenges. These events present more logistics than the shorter events including providing housing and food over multiple days. Bootcamps should be structured to include takeaway learning outcomes for student and an integrative project to foster new content and skill development (Tranquillo, 2013a). Like other rapid design events, bootcamps have very few lectures and more hands on activities. West et al. (2012) exposed 93 students from engineering, design, and education to a two-day boot camp where they worked in multidisciplinary teams and learned innovation principles through design challenges and innovation discussion. By using the Torrance Tests of Creative Thinking as a metric, the researchers found that the bootcamp helped students improve their divergent thinking skills.

Processes for Innovating in the 21st Century

The phrase “design thinking” originated from design firm IDEO through David Kelley’s, its founder, use of the phrase to describe how a designers’ work (Brown & Wyatt, 2010). Design is simply how a designer sees and think as they are situated in their design environment (Liu, 1996; Suwa, Gero, & Purcell, 2000). The characteristics of a design thinker are: high tolerance for ambiguity, curiosity, and visual thinker (Fry, 2006). They can make analogies and transfer knowledge from one discipline to a new application in a new discipline. Dorner (1999) describes four forms of a design process. The first form is a “cloudy” idea about the functions of a solution. In the next form, the idea is made more concrete through the use of models and sketches. To further elaborate on the idea, the next form consists of visuals and verbalization, or a “picture-word cycle”, which locates weak areas of the idea. As Suwa, Gero, Purcell (2000) states “it is not until externalizing on paper the ideas of what they think might be a potential solution and inspecting them that designers are able to find new aspects of the problem and to generate new ideas” (p. 540). The final form consists of locating and removing “contradictions” from the idea. Brown and Wyatt (2010) describes the design thinking process as a system of non-sequential overlapping spaces including inspiration, ideation, and implementation. Inspiration is the problem or opportunity that motivates designers to search for solutions, ideation is the process of generating, developing, and testing ideas, and implementation involves the path that leads from the project stage into production. Design thinking teaches students important skills such as working with ill-defined problems, developing empathy, problem framing, risk taking, paying attention to details, learning from failure and perseverance (Cross, 2011). Razzouk and Shute (2012) recommends design instructors engage students by providing an environment with multiple opportunities for creating and improving prototypes, idea experimentation, collaboration, and reflection.

Team dynamic also affects progression through a design process. By studying three mechanical engineering design teams with four to six students, Stempfle and Badke-Schaube (2002) found that design teams spent only ten percent of their time on clarifying the goal and spent the remaining ninety percent of the time planning a solution. However, McNeill, Gero, and Warren (1998) studied electronics engineering who spent most of their time analyzing the problem.

In addition to design skills, the development of an entrepreneurial mindset is important for the 21st century workplace. Entrepreneurship is defined as "the desire to achieve, the passion to create, the yearning for freedom, the drive for independence, and the embodiment of entrepreneurial visions and dreams through tireless hard work, calculated risk-taking, continuous innovation, and undying perseverance" (Ma & Tan, 2006, p. 704). Entrepreneurship engages students in opportunity recognition, strategic decision-making, validated learning, and generating, evaluating, and selecting alternatives to a problem situation. It teaches students how to use validated learning, running frequent experiments to test each aspect of their product, to discover valuable truths about its' viability and future business prospects (Ries, 2011). At least 131 United States colleges and universities have entrepreneurship centers, academic departments, majors, minors, concentrations, special certificate or courses (Levenburg, Lane, Schwarz, & Rapids, 2006). However, many universities face difficulties to integrating an entrepreneurship culture on campus including: "(i) a national culture that does not support entrepreneurial behavior and risk-taking, (ii) geographical isolation and/or limited local market, (iii) lack of venture capital or multinational companies in the region, and (iv) no existing high-ranking research-led university within the ecosystem base" (Graham, 2014, p. 12). These difficulties have led to many student-led entrepreneurship initiatives on campuses, which involves students organizing events and activities creating a "bottom-up" approach to developing an entrepreneurial culture.

Engineering programs, specifically, have taken a greater interest in exposing students to entrepreneurship. Duval-Couetil and Reed-Rhoads (2012) surveyed 501 engineering students to uncover the role of entrepreneurship in their engineering program. Most engineering students believe that entrepreneurship education can increase their career prospects and choices even if they intend to work for organizations after graduation. The survey also revealed that taking one entrepreneurship course could increase an engineering students' entrepreneurial self-efficacy. Eesley and Miller (2012) found that sixty percent of Stanford University graduates who go on to become "quick founders," defined as those receiving venture capital funding within three years, had taken an entrepreneurship course. Fifty percent of those quick founders had participated in entrepreneurial competitions and programs. Ohland, Fillman, Zhang, Brawner, and Miller (2004) studied a program that sought to improve interest in entrepreneurship and increase retention and performance by engaging engineering students in meaningful design experiences early and throughout their academic careers. Freshmen who participated in an entrepreneurship course were more likely to persist in engineering and had higher GPAs on average than students who were not exposed to entrepreneurship. These results have led to many programs encouraging their students to market the products they create. For example, in computer science there is the concept of startup engineering – getting a product to work well enough for people to buy, and then improving it iteratively ("Stanford Startup Engineering," n.d.). The attributes of the lean startup method, a term coined by Eric Ries, are conductive to utilization in a college entrepreneurial experience. This approach focuses on quickly developing business model hypotheses, and testing the most critical hypotheses through developing "minimum viable products," gathering feedback from potential customers, and then improving on the design (Eesley & Miller, 2012; Ries, 2011). Integrating lean startup concepts into curriculum activities consists of placing ideas constructed from the projects into production and generating income. This blended activity offers students the opportunity to produce innovative products and services that can lead to successful businesses while they have the resources of a higher education institution.

The Role of Situativity Theory in Learning Environments

College graduates who intend to engage in problem solving or entrepreneurship professions need exposure to activities that will emulate the context they will encounter after graduation. Formal design classes have trouble providing this experience due to its highly structure format, and inability for students to take risks due to grading assessment. Situativity theory (or situated learning) will be used as a guide for developing design activity environments that properly emulate a professional context.

Situativity theory evolved from cognitive psychology as some theorists began focusing on the "when and how" of knowledge use over focusing solely on learning content (Durning & Artino, 2011). An important study in the development of situativity theory involved Lave (1988) investigating the differences in how learning occurs in everyday activities and in schools. She discussed homemakers who performed arithmetic better when making calculations at the market than when solving paper-and-pencil math problems. This example and others led her to conclude that how people learn in typical contexts differs from how students are expected to learn in a school setting. This discrepancy in transferring knowledge in different contexts was also shown in studies from Godden and Baddeley (1975) where divers couldn't transfer learning from land to water and vice versa, and Carraher, Carraher, and Schliemann (1985) where Brazilian children could perform math with buying and selling items on the street, but couldn't transfer those skills to the classroom.

Situativity theory proposes that learning can not be separated from the context in which the knowledge will be used (Brown, Collins, & Duguid, 1989). Situativity extends from theories such as social constructivism and experiential learning. Social constructivism, stemming from research by Vygotsky and Bruner, proposes that cognition, and therefore learning and knowledge, are shaped by cultural and social contexts, and interactions (Rogoff & Lave, 1984; Schommer, 1998). This collaboration causes learning gains in the individual and the community as a whole. In activities based on this theory, learners participate in group cognition where a small group of learners engage in activities collaboratively to construct knowledge. Situativity differs from constructivism because situativity theorists believe that learning and thinking happens at the intersection of the learner and the environment rather than constructed in the learner's mind.

In situated learning, emphasis is placed on knowledge progressing through human activity and social interactions. Knowledge is thought of as a tool that cannot be utilized unless there is understanding about its context. Learning occurs when there is recognition of the use of constructed knowledge to solve real-world problems. In order to properly learn how to use tools as practitioners use them, students need to become apprentices of the practitioners' community and learn its culture. Traditional teaching techniques too often ask students to take on the knowledge of a discipline without allowing immersion in its culture. As a result, students engage in activities that actual practitioners would not undertake. Learning through textbooks and lectures promote isolated and over-simplified understanding (Brown et al., 1989). Young (1993) proposes that for a context to be authentic it must contain attributes such as ill-structured and complex goals, the ability to decipher between relevant and irrelevant data, problem finding, defining, and solving opportunities, connections with students' beliefs and values, and collaborative activities. Assessment in situated activities must also differ from traditional methods in direct instruction. Determination of successful learners should be based on how learners perceive information in the learning situation rather than right and wrong responses (Young, 1993).

Participating in ill-structured situated activities assists students in developing the ability to change perspectives in a problem solving setting and demonstrate the use of cognitive flexibility. Cognitive flexibility is a person's ability to think from multiple viewpoints (Spiro, 1988). Cognitive flexibility is also strengthened through a diverse set of knowledge structures while deconstructing problems from multiple disciplinary viewpoints. Situated learning activities integrate many conditions of learning for cognitive flexibility including (Chieu, 2005, p. 53):

1) Preparing a diversity of meaningful learning situations emphasizing the nature of the underlying concepts;

2) Preparing multiple external resources related to the underlying concepts (including people and physical and online tools);

3) Encouraging learners explicitly to examine different interpretations of the underlying concepts to express their personal points of view on the underlying concepts, and to give feedback on the points of view of other people; and

4) Encouraging learners explicitly to run a variety of discussions with other people in different contexts.

Practice fields. A technique for exposing students to authentic design experiences is through the use of practice fields. Practice fields are learning environments that provide authentic contexts to engage students in activities they will participate in when they enter the workforce (Land, Hannafin, & Oliver, 2012). Peter Senge first used the phrase “practice fields” when discussing strategies for building learning organizations. He describes an ideal setting of a practice field by stating:

> People are actively doing what they want to be able to do well. They are making mistakes, stopping, trying again, talking about what’s working and what isn’t, and gradually developing a greater ability for effective action in the “performance fields”, where results matter (Senge, 1990, p. 300).

Although separate from the actual field, students can imitate the performance of an actual professional by contextualizing knowledge and applying it to different contexts, supporting transfer (Jiusto & DiBiasio, 2006). These experiences help students find their niche, matching their learning with their personal goals, needs, and interests while becoming more engaged in their studies (Cheville & Bunting, 2011). Barab and Duffy (2012) provide design principles for practice fields including offering coaching and modeling of thinking skills, an opportunity for reflection, ill-structured problems, and a motivating learning context. Like with teaming and other short-term design activities, participating in practice fields often require working together in a temporary context around a particular task.

Practice fields primarily make use of problem-based learning (PBL), anchored instruction, or cognitive apprenticeship (Barab & Duffy, 2012). Problem-based learning consists of students working in teams developing solutions to open-ended authentic problems (Prince & Felder, 2006). Hmelo-Sliver (2004) delineates five student goals of PBL activities: "1) construct an extensive and flexible knowledge base; 2) develop effective problem-solving skills; 3) develop self-directed, lifelong learning skills; 4) become effective collaborators; and 5) become intrinsically motivated to learn" (p. 240).

The concept of PBL was developed through the need for medical students to have access to authentic patient case studies to develop their diagnosis skills. Researchers found that students who engaged in PBL curriculum were more likely to use hypothesis-driven reasoning than students engaged in traditional curriculum (Evensen & Hmelo-Silver, 2000). Zhou, Kolmos, and Nielsen (2012) interviewed ten students and two supervisors to investigate how engineering students are motivated to develop group creativity in a PBL environment. The researchers found that student motivation was affected by many attributes such as formal and informal group discussion, supervisor meetings, shared leadership, common goals, and peer support openness. By interviewing ten engineering students, Fenzhi (2014) found that PBL activities assisted most of the students in confronting conflicts through a learning trajectory of first showing positive attitude towards conflicts, then using self-reflection as a way to convert conflict into creative ideas, and lastly gaining a deeper understanding of the project and a broader knowledge of handling conflicting situation. A few students had negative or mixed attitudes towards conflicts, which slightly altered their learning trajectories by creating relationship issues with team members. Using ten PBL evaluation principles, outlined by the Joint Committee Standards, on a creative community of instructors and students creating animation videos, West, Williams, and Williams (2013) discovered that a successful PBL environment established a context and culture of high expectations, collaboration, and evaluation, united students, teachers, and industry leaders as shared stakeholders, and gathered information on important criteria for evaluating progress.

Anchored instruction is similar to PBL because a real problem context is used, however the problem is not necessarily an existing or prior case. Students are expected to engage in the problem as if it were a real situation. The Cognition and Technology Group at Vanderbilt (1990) describes the use of "macro-contexts" as rich and complex situations that can anchor instruction across multiple perspectives. Zech et al. (1998) used anchored video to teach geometry to students in 5^{th} – 8^{th} grade. Using a video series called Jasper, where each story consists of a 15-20 minute video where characters of the story eventually encounter a challenge that the students must solve, the researchers found that 84 of 106 students improved on their understanding and drawings of geometric figures.

Cognitive apprenticeship involves fostering an environment in which experts model and guide learners through the necessary cognitive activity needed to solve a problem (Collins, Brown, & Newman, 1989). In addition to demonstrating how to perform a task, experts also provide scaffolding when learners begin performing a task, removal of the scaffolds (called fading) when learners gain more experience, and general coaching for increased chance of learner success (Singer, Nielsen, & Schweingruber, 2012). Expert modeling is often presented in the form of reciprocal teaching (teacher and learner take turns in the role of instructor and learner), or expert think-aloud (verbally expressing thought process while progressing through a problem) (Barab & Duffy, 2012). Cognitive apprenticeship is based on Vygotsky's concept of zone of proximal development (ZPD). ZPD is the "distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotskiĭ & Cole, 1978, p. 86). This concept makes the type of context in which learning is taking place important. Heller, Keith, and Anderson (1992) studied 120 students taking a physics course and discovered higher performance among the students when they worked in groups and the instructors were able to teach and model a general problem-solving strategy. Hundhausen, Agarwal, Zollars, and Carter (2011) used software scaffolding to provide guidance and dynamic feedback to assist engineering students in solving problems and equations. Consistent use of this software helped students overcome basic syntax and semantics misconceptions.

Developing a Community of Practice through Authentic Activity

As mentioned earlier, students who engage in practice fields do not generally contribute to any actual field. Therefore, as they repeatedly participate in situated activities it is important to support their involvement in the community for the practice in which they are engaged. While in the community they begin to take on the behaviors of the community by using jargon, internalize its social norms, and engage in meaningful participation (Brown et al., 1989). These knowledge creating communities have many characteristics including, participants who are excited to share ideas and discoveries and have multiple perspectives, experimentation, specialization, cognitive conflict and discussion, reflection, and synthesis (Bielaczyc & Collins, 2006). Members of the community transfer ideas and lessons learned as they move across teams within the community, which helps spreads those ideas throughout the community.

Barab and Duffy (2012, p. 47) state that when distinguishing practice fields from learning communities it is necessary to know:

> (1) whether there exists a sustainable community with a significant history to become enculturated into, including shared goals, beliefs, practices and a collection of experiences;
>
> (2) whether individuals and the community into which they are becoming enculturated are a part of something larger; and
>
> (3) whether there is an opportunity to move along a trajectory in the presence of, and become a member alongside, near peers and exemplars of mature practice.

Communities of practice. In situated-based learning environments, the instructor becomes a member of the community of practice (facilitator, co-learner, expert, evaluator), and students increase their role in the community through participation in authentic learning environments in which they solve real problems typical of the community (Newstetter & Svinicki, 2014). Communities of practice foster knowledge building and exchanging, and developing practice skillsets among individuals of equal status (Johnson & Johnson, 1989; Wenger & Snyder, 2000). Wenger (1998) proposes that community participation assists in the development of identity, meaning, and knowledge formation. Three elements are necessary for the effectiveness of communities of practice: joint enterprise, mutual engagement in learning, and a shared repertoire of resources. Joint enterprise occurs when participants know the goals of the community and their role. Ideas, tools, and information, and other resources contribute to the shared repertoire within the community. When mutual engagement occurs within the community, participants are "willing to share ideas, to admit their own ignorance, to ask difficult questions and to listen carefully to the other members" (Cheng & Lee, 2014, p. 753). Members of a community of practice not only have complementary competencies, but also overlapping competencies because members often exchange knowledge.

The social process of transferring from a new member of a community of practice to an experienced participant is a concept called legitimate peripheral participation (Lave & Wenger, 1991). Eberle, Stegmann, and Fischer (2014) studied fourteen faculty student councils to determine the structures used to facilitate the legitimate peripheral participation of new community members, and how those structures predict students' level of participation. The structures that were discovered included the ability for newcomers to observe senior members, engage in manageable small tasks, or work on complex tasks with senior members. The researchers also found that accessibility to community knowledge, smaller communities, and increased exposure time can increase the participation level of newcomers.

Community development is considered integral to design and entrepreneurship activity (Hindle, 2010). To increase entrepreneurial mindset among computer science students, Rohde, Klamma, Jarke, and Wulf (2007) organized a community of practice between students and local startup companies. Students engaged in a university course that fostered project-based learning while engaging in peripheral participation through real-world tasks and shared practice with entrepreneurs. Through interviews, the researchers learned that "incompatible social-cultural backgrounds and incommensurable mutual expectations" prevented a true development of a community of practice between the two startup companies selected and the student teams. The physical distance between the startup companies and the university also made community building difficult. However, the researchers reported a deep sense of community among the students and their teams. Changes were made to the course including choosing startup companies that were more stable, bigger student groups, and assigning each student group a tutor. These changes improved the development of community among the startup companies and students. However, the community among the students remained stronger.

Design and Entrepreneurship Practice Fields in Higher Education

Design and entrepreneurship practice fields prepare students to become leaders in organizations that foster rapid innovation creation. Boni et al. (2009) state that “these organizations involve interdisciplinary design thinking from the earliest stages, incorporate a user perspective, evolve strategies, products, and services iteratively in an emergent manner, seek outside help as required, are prepared to move quickly, and are not constrained by the internal resource allocation process (p.408).”

Universities have begun to offer design practice fields through disciplinary capstone projects and interdisciplinary product design and development courses (Fixson, 2009). At the University of Michigan, the College of Architecture and Urban Planning offers a course called “Launching Design Practices”. The course is promoted as a startup opportunity for architectures without the normal repercussions of failure – losing money or professional reputation. In the fall of 2007, Stanford University offered a “Facebook Class” to its computer science students allowing them to create applications for Facebook and obtain users. The theme for the course was “Make things simple, and perfect them later” (Helft, 2011). The apps that were created from the class generated around $1 million in revenue. Many of the students turned their projects into businesses after the class ended. Carnegie Mellon University offers a capstone project course called “Designing and Leading a Business,” which involves students from design, technology, and business collaborating to design solutions for outside companies (Boni et al., 2009).

During the development of their capstone design courses, Hyman, Khanna, Lin & Borgford-Parnell (2011), and Paretti (2008) found through case study research that these design activities are used to develop students' collaborative, communication, and management skills.

A course consisting of 11 art students and 9 engineering students participating in design teams at the University of Georgia reflected the benefits of introducing design in a interdisciplinary context (Costantino, Kellam, Cramond, & Crowder, 2010). Through surveys and focus groups, the engineering students in the course reported increased appreciation of the use of imagery to convey a concept and became knowledgeable in making presentations more creative and visually appealing. In fact, one engineering student reported that collaborating with students from different disciplines and therefore from different perspectives helped her to look at problems from different viewpoints.

A multidisciplinary course at Virginia Tech focused on engaging students in creating wearable and pervasive computing products. The goals of the course were for students to gain an appreciation for other disciplines, demonstrate knowledge expertise, and learn the skills needed to contribute to an interdisciplinary design team (Martin, Kim, Forsyth, McNair, & Coupey, 2011). The instructors administered the Team Diagnostic Survey each year the class was taught to measure students' self reported perceptions of team cohesion and effectiveness. They found that the teams were more effective when there was "clarity of the class structure, prototyping exercises, and disciplinary balance" (p.13).

Instructors at Purdue University exposed 13 undergraduate engineering students to a three-week summer course where students were fully immersed in a design activity, which involved making a summer camp more accessible to children with physical disabilities. Through a combination of qualitative and quantitative methods, the instructors found that the experience significantly increased the students' understanding of design and the role of users and stakeholders (Cummings, Zoltowski, Hsu, Cardella, & Oakes, 2014).

While these courses have shown promise, many barriers to offering immersive interdisciplinary design and entrepreneurship activities remain including instructor and student motivation, location of class, and a complementary time and day for the class to take place (Costantino et al., 2010). Many students are interested in taking these types of classes but often cannot fit them into their schedule or the classes are not accepted for degree requirements. These courses also do not provide the opportunity for students to engage in rapid immersive design activity. Students are given weeks to complete a project, and must integrate working on the project with other academic responsibilities.

Students who participate in design activity in college often use the skills learned in their workplace. Royalty, Oishi, and Roth (2012) surveyed 184 alumni from various programs such as business, engineering, arts and science, law, and medicine, who had taken design thinking courses on their use of design thinking in their careers. The survey participants responded that they use skills related to design at least 2-3 times per week mostly related to empathy, prototyping, and brainstorming. Through interviews, the researchers learned that taking the design courses fostered creative confidence and a tolerance for risk and failure in the alumni. The participants reported learning these skills primarily through "working on real applied problems, doing field work, their project demonstrations, and working on cross-disciplinary teams" (p. 102).

A Conceptual Framework for Developing Informal Interdisciplinary Rapid Design Practice Fields

Decisions for designing features in a learning environment should be theoretically grounded (Jonassen & Land, 2012). Newstetter and Svinicki (2014) state “designing learning environments without learning theory is comparable to designing a bridge without mechanical laws and principles” (p. 29). This section will use concepts from situated learning theory and communities of practice to provide a conceptual framework for developing design practice fields. Based on the situativity theory, practice fields should have the following attributes: 1) authentic activities and resources and 2) community formation. The goal of this conceptual framework is to describe the elements of an informal rapid design activity environment, and provide a structure that practitioners can use to inform design features. John Dewey proposed involvement of students, available space for experiencing, deductive instruction, and possibilities for construction as attributes essential for a successful learning design (Noweski et al., 2012). When choosing the elements of the framework that promote community and authentic activity, consideration was given to people (who should be there?), place (where should it take place?), and program (what should happen?), and then how those elements combine to promote a culture (what is the structure?). Use of this model to develop interdisciplinary design thinking activities assist institutions in engaging students in high-impact educational practices (HIPs). Kuh (2008) proposes that HIPs builds “broad knowledge, strong intellectual skills, and a grounded sense of ethical and civic responsibility (p.13).” Of the many HIP example activities Kuh discusses, common intellectual experiences, learning communities, collaborative projects, and community-based learning are most aligned with the model proposed in this research.

People. Design and entrepreneurship teams in industry consist of professionals from a variety of backgrounds. Innovation creation develops best in teams with diversity based on skills and experiences (Justesen, 2004). Therefore it is necessary to equip design practice fields with the same diversity. Simulation of future work situations is a key preparatory experience for all students. For students of professions that constitute the creative class to truly simulate their future work context, interdisciplinary collaborative experiences are needed. These experiences allow students to integrate methods and perspectives of multiple disciplines to create new knowledge (Borrego, Newswander, & Mcnair, 2007). Students who learn across disciplines gain many essential skills such as the ability to recognize organizing principles, change perspective, and identify the context of the problem or question under investigation (Kreber, 2009). Students also learn the ability to organize time and resources to meet milestones, and develop personal, group, and project management strategies (Sheppard et al., 2008). Learning in an interdisciplinary context increases a student's empathy towards ethical issues and bias, ability to overcome ambiguity, encourages original thoughts, and increases humility (Newell, 1994). Participating in interdisciplinary collaboration also fosters empathy for other disciplines. Once students gain more knowledge about useful disciplines, they can develop greater appreciation for the discipline and integrate its concepts into their own work. This technique, known as conceptual blending, is essential to generating innovative solutions (Fauconnier & Turner, 2002). Many graduates have stated that these interactions prepared them the most for work in industry (Cobb, Agogino, & Beckman, 2007).

While ideas from diverse groups are generally more innovative (De Dreu & West, 2001), diverse groups also experience higher levels of conflict (Jehn, Chadwick, & Thatcher, 1997) and lower levels of cohesiveness (Jackson et al., 1991). These conflicts are often due to cultural and mindset differences. (Dickey, 2010; McNair, Newswander, & Boden, 2011). Dickey (2010) explained how cultural differences between computer science students, and art and design students affected their video game collaboration. She described the computer science students as "conservative, both in their style of dress and in their interactions with each other and the other students in the class" (p. 169). The computer science students were only interested in the programming aspect of the video game and creating complex algorithms. The art students were described as a "diverse, visual, verbose, and eclectic group of students, who were very liberal in their styles of dress and interactions, and desired to create and challenge the status quo" (p. 169). These differences led to disagreements over important aspects of the game such as the storyline and character development. To resolve cultural barriers, Martin et al. (2011) discusses techniques such as showing examples of interdisciplinary teams in industry, introducing each discipline to students, explaining terminology differences, having an equal number of students from each discipline on a team, and meeting in a neutral environment so that no students feel like guests during the collaboration. Bielaczyc and Collins (2006) proposes using respectful listening to resolving differences in the team, and using logic and evidence over authority to make decisions. Despite the potential for conflicts, participation in interdisciplinary collaboration can increase students' "understanding of the challenges of other disciplines, communication skills, and ability to compromise in order to achieve a shared objective" (Hoekstra & Morris, 2009, p. 1).

Place. The physical space where design and innovation work is performed is important for fostering a creative mindset. Bielaczyc and Collins (2006) state that "communities think and respond to new situations by synthesizing new solutions from bits and pieces that are scattered around in the environment" (p. 44). These physical spaces need to be flexible, open, and inviting to students from all disciplines. Spaces that foster design thinking should situate the learning process and foster connections with people and their ideas (Narum, Whitmer, & Miller, 2011). A flexible learning space has been found to positively impact interaction and creativity in teams (Kim & McNair, 2009). A space specifically developed for innovation is beneficial because it creates a "circle of exchanges" among participants, providing a revolving access to new ideas, disciplines, and people (Wheatley, 2006). This type of social learning space can provide students with an outlet to develop social networks with peers that can lead to greater engagement in active and collaborative learning, and facilitates the sharing of knowledge to meet academic challenges (Matthews, Andrews, & Adams, 2011). Learning spaces are not just venues for collaboration but can serve other needs as well. McIntosh (2010) proposes seven types of spaces for innovation: 1) private space: a place to be ourselves; 2) group space: where small teams can work together; 3) publishing space: showcases what is going on; 4) performing space: share or act out ideas; 5) participation space: allow personal engagement with what is going on; 6) data space: library or database for information archival; and 7) watching space: passively observe what is happening around us. To foster creative collaboration, Rogers (2012) recommends providing space for team members to work in solitude and non-work spaces for informal communication.

Learning in a flexible space can create a "third space" among the participants in a community. The third space (also referred to as a third place) refers to informal public gathering places centered on conversation (Santasiero, 2002). Third space is a transformative space where the potential for an expanded form of learning and the development of new knowledge are heightened. Shaffer (2014) explains the benefit of having access to this type of space by stating: "by having an area where we can incubate and build, and not necessarily always worry about what a failure it is, we understand that we can learn from it. It really allows us to amplify and create new seedlings, off which we can build more crops (3:23)." Third spaces are important for higher education because they afford students opportunities to test ideas and opinions in a setting free from the formal classroom environment. When a third space is used in a design context, students response to the design activities with a clearly articulated sense of their confidence and agency, and more specifically, of their identities as change agents (Goldman et al., 2012). Students interacting in a third space begin to make formal knowledge an active part of their lives (Eisenhart & Edwards, 2004). Instructors can facilitate a third space environment with students by departing from "their rigidly scripted and exclusive social spaces" (Gutierrez, Rymes, & Larson, 1995, p. 467) in favor a more open learning space.

A great example of a third space environment can be found at Stanford's d school. In her book *What I Wish I Knew When I Was 20*, Tina Seelig (2009) describes the flexible and creative nature of the d school:

> The d.school classroom space invites experimentation. All of the furniture is on wheels and moves about easily to create different workspaces. Each time students arrive, the space is literally configured differently. Bins of paper, wood, plastic, paper clips, rubber bands, colored pens, pipe cleaners, and tape invite them to build prototypes to bring their ideas to life. The rooms are filled with movable white boards covered with colored stickies for brainstorming. The walls are peppered with photos and artifacts from past projects that serve as inspiration for creative thinking (Kindle Locations 1968-1972).

Using the physical and social context of an environment to promote learning connects with a theory related to situativity called ecological psychology. Theorists of this perspective believe it is impossible to separate the learner and the environment in which learning occurs (Durning & Artino, 2011). The affordances and abilities of the environment direct the learners' goals and intentions, which produce learning and problem solving. Ecological psychology builds upon situativity by explaining participants use goal-directed activity to interact with other learners and their environment. Young (1993) states “an ecological approach to instructional design must include a new approach to assessment, moving away from static assessment to situated assessment that incorporates both the affordances of the environment as well as the abilities brought to the situation by the student” (p.56).

Program. Activity in rapid design practice fields should emulate real professional settings. These activities should facilitate a form of problem-based learning by allowing participants to find and solve problems important to them. It is important to engage rapid design event participants in a form of a problem-based learning activity and anchored instruction termed “challenge-based learning.” Challenge-based learning is defined as a multidisciplinary learning approach that fosters the use of technology integration to solve real-world problems (Johnson, Smith, Smythe, & Varon, 2009). Challenge-based learning begins with a big idea, a problem of global importance that the teachers and students want to solve. Essential questions about the big idea are formed and a challenge for the students is created. Students then use guiding questions, activities, and resources to develop an actionable solution that they can then test. Klein and Harris (2007) designed the Legacy Circle as a process to facilitate a form of challenge-based learning. The elements include the challenge, generating ideas, multiple perspectives, researching and revising, testing the ideas, and going public with the solution. Johnson and Adams (2011) studied 65 teachers and administrators who facilitated challenge-based activities to students ranging from third grade through college. Through reflection, ninety percent of the instructors reported that students improved in skill areas including leadership, collaboration, flexibility, adaptability, creativity, critical thinking, communication, and innovation. The instructors did not mention how the improvement was determined.

Challenge-based learning activities engage students in 21st century skills due to its focus on solving ill-structured problems. Ill-structured problems involve data that are incomplete and an uncertainty about the correct solution. Ill-structured problems require observations through multiple perspectives. Students must “consider alternative arguments, seek out evidence, evaluate its trustworthiness, and construct a solution that is itself open to question and further evaluation” (Lattuca et al., 2004, p. 33). Challenge-based learning is an effective tool for student engagement because like problem-based learning it facilitates the learning cycle of doing, feeling, watching, and thinking (Patterson, Campbell, Busch-Vishniac, & Guillaume, 2011).

Challenges can come from a wide range of topics and backgrounds. The National Academy of Engineering (2008) created a list of Grand Challenges to alert the public to the critical problems of our generation. Grand Challenges include issues such as providing access to clean water, advancing personalized learning, and reverse engineering the brain. While the challenges are aimed at the engineering profession, exposing the challenges to students from various disciplines can lead to more innovative solutions. Challenges can also connect with the local community by engaging students in place-based learning. Place-based learning activities are designed to ask questions related to the conservation, transformation, and restoration needs of a particular place (Gruenewald, 2008). Participation in these activities can develop students' empathy towards community, increase their confidence in their ability to improve a community, and increase student engagement in multidisciplinary and experiential learning (Gruenewald, 2003; Mathews, 2013).

Culture. Defining a culture is essential for developing a learning environment, as it influences what occurs within the structure of the environment. Rapid design activity environments should seek to foster a culture in which community cohesion is paramount.

Students involved in repeated situated collaborative design activities that uses the aforementioned elements of people, place, and program, engage in a community of innovation. A community of innovation (COI) is one in which the desire to innovate forms and binds the community (West, Young, & Hannafin, 2011). Communities of innovation and communities of practice are related in that a community of practice can function as a community of innovation, or after innovation development has completed, a community of innovation can be transferred into a community of practice. However, communities of innovation differ from communities of practice in that they involve creating innovation, are often improvised and their boundaries tend to change, thus creating dynamic relationships. West (2009) also explains the need for a COI by stating:

> I do not assume that one framework is preferable to another, only that they promote different kinds of learning and working based on a conception of what is mutually shared, either shared practice or shared innovation. My argument is that community of practice frameworks are very effective in some situations, but that our evolving innovation economy requires us to also consider the need for communities whose primary focus is on innovation. (p. 27)

The adaptive and ill-defined structure of a community of innovation increases the probability that collaborative brainstorming, reflection, creation, and product innovation emerges. These activities increase the chance that inquiry, reflection, and an entrepreneurial mindset will occur. Other attributes of COIs include idea prototyping, learning through critiquing, and development of group flow (West et al., 2011). These features were uncovered through critical incident interviews that were conducted with graduate students enrolled in studio design courses (West & Hannafin, 2010). West also identified potential barriers to creating a

COI including lack of enough time to focus on innovation, lack of prerequisite technology skills, and collaboration only within small peer groups within the community. Mishra et al. (2006) used the term "community of designers" (CODs) to define a group of individuals collaboratively designing solutions to authentic problems. CODs experience four stages throughout its lifecycle: identifying participants and problems, forming communities, providing leadership and support, and working on authentic problems (Mishra et al., 2006).

Practice fields based on community of innovation principles are better suited for students going into creative class professions than communities of practice as they more accurately reflect the rapid, dynamic, ill-structured context of the innovation workplace. While students participating in traditional practice fields are not expected to contribute to their field, design practice fields foster the opportunity to create new projects and businesses thus contributing to the design and entrepreneurship community. In West et al. (2011), the authors discussed several avenues for furthering the development of COIs. During this discussion, several questions were posed. Two of the questions that begin to be addressed through this conceptual framework are related to the value of COIs and knowledge and expertise acquisition in COIs. This framework proposes that the following elements- people, place, and program, are needed to form a successful COI in which the knowledge and expertise acquired is a design thinking mindset and the value is the development of the skills desired by employers.

A model for developing informal design practice fields. Figure 2 displays a model for developing an informal design practice field through the creation of a community of innovation. West's community of innovation model primarily focuses on the attributes of the people in the community and some of the processes and goals of the community. This model presents an in-depth investigation into the attributes of the people in the community, the place where the collaboration takes place, and the program (or activities) that engages participants in innovation creation. These elements merge causing separate learning outcomes to be distributed among individuals and teams that comprise the community. Individual outcomes include the development of leadership strategies, increased empathy and design thinking capability, promotion of conceptual blending, development of a change agent identity, and acquisition of innovation skills (including creativity, collaboration, communication, and critical thinking). Team outcomes include creative collaboration, the ability to develop a circle of exchanges, an enlarged network, promotion of risk taking culture and innovation, and the opportunity to emulate real rapid design teams.

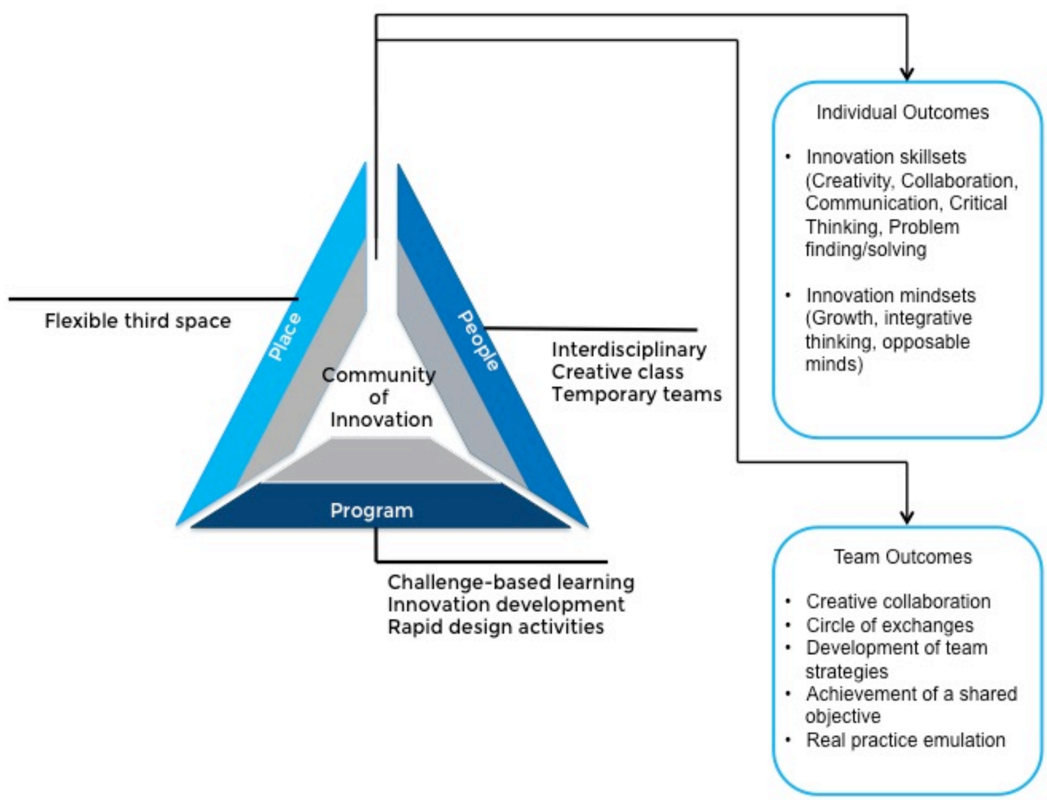


Figure 2. A model for developing design practice fields.

Summary

This chapter discusses the influence of experiential learning in design thinking informal environments. Extracurricular activities, an informal environment commonly found in higher education, can be used to develop innovation mindsets and skillsets in students. This chapter also introduces situated learning theory and discusses its role in designing effective learning environments. One type of situated learning tool, a practice field, can be used to engage students going into creative class professions to the type of context they will encounter in the workplace. As students participate repeatedly in a design practice field, they begin to form a community that contributes to innovation creation. While universities have begun to offer design experiences, there is a need to develop activities that are rapid, immersive, and make use of the openness of informal environments. A conceptual framework was presented that utilizes three elements: people, place, and programs to provide a model for developing a community of innovation environment that expose students to rapid design activities. The next chapter will discuss the development of a rapid design and entrepreneurship event, the use of educational design research to evaluate its effectiveness and offer design principles for generalizability, and investigation on how a community of innovation forms and evolves during a rapid design event.

CHAPTER 3
METHODOLOGY

The purpose of this study was to use an educational design research process to investigate how a rapid design practice field can prepare students entering fields involved with innovation for the type of context they may encounter in the workplace. Professionals in these fields use design and entrepreneurship concepts while working in adaptive interdisciplinary teams to create new products and services. This study investigated the principles involved in developing an authentic environment for rapid design activities. These principles will guide practitioners as they design their practice fields. The study also investigated students' experiences while participating in a rapid design event to uncover what elements of the practice field students find engaging and how a community of innovation forms. This chapter will discuss in detail the elements of the educational design research approach used over a two-year period to develop a rapid design practice field, including a pilot study and a second iteration of the environment.

Research Questions and Methods

This educational design research project was primarily guided by the following overarching research question:

- What design principles can be derived from the development of an informal design and entrepreneurship event?

The pilot study focused on two additional research sub-questions:

- What attributes of the practice field do students find engaging?
- How can the practice field support the continuation of projects beyond the event?

The second iteration of the study added three new research sub-questions:

- How can communities of innovation form during rapid situated design activities?
- How can just-in-time learning tools provide scaffolding to support innovation in these communities?
- How can participants in these communities overcome challenges?

Operational Definitions

To develop rapid design events, practitioners need to follow guiding principles. The design principles I used were grounded in both implementation and theoretical insights. The creation of these principles is necessary to guide practitioners when developing rapid design events. McKenney, Nieveen, and Van den Akker (2006) propose that "design principles are not intended as recipes for success, but to help others elect and apply the most appropriate substantive and procedural knowledge for specific design and development tasks in their own setting" (p. 73). As this study is in the early stages of the design research process and requires further testing, I expect that the principles generated will change after more implementations of the environment. However, these design principles can act as a starting point for practitioners.

The just-in-time learning tools used during the rapid design activity are a card game, popup classes on design and entrepreneurship concepts, and 15-minute sessions with mentors. I explain these tools below, under "Research Context."

Educational Design Research Approach

I chose the educational design research approach because it is effective in helping teachers improve instruction and real-world learning. Educational design researchers seek to develop empirically grounded theories by conducting studies on both the process of learning and its structure (Akker et al., 2006). Educational design research is unique in that it is intended to enable researchers to design a solution to a problem in an iterative, real-world context while simultaneously attending to issues of process, utility, and theory. Barab and Squire (2004) describe educational design research as "a series of approaches, with the intent of producing new theories, artifacts, and practices that account for and potentially impact learning and teaching in naturalistic settings" (p.2). Educational design research differs from traditional research in that researchers combine design features with theory to create new contextually grounded theories (Barab & Squire, 2004). Advocates of educational design research state that the approach is most useful when researchers have the following goals:

1. Explore possibilities for creating novel learning environments,
2. Develop theories of learning that are contextually based,
3. Advance and consolidate design knowledge, and
4. Increase the educational community's capacity for educational innovation

(DBRC, 2003, p. 8).

Design activity practice field practitioners do not have adequate research studies and design theories to support the development of informal learning environments. The initial goals of this project were, first, to design a rapid design event that would foster interdisciplinary collaboration and innovation building, and second, to develop design principles and a model for constructing rapid design practice fields. After the pilot study, I added two additional goals. My third goal was to investigate how communities of innovation form and how best to support them. My fourth goal was to use sustainable innovative learning environments to contribute to situated design and entrepreneurship activity in higher education. The unique emphases of design research made it the best method for investigating my research questions and achieving these goals.

Stokes (1997) used a matrix to visualize the connection between research for theoretical understanding and applied research. He denoted the upper right part of the matrix “Pasteur’s quadrant” to describe use-inspired basic research, and he advocated for more research in this area. Educational design research fosters investigation that occupies this quadrant, and promotes long-term engagement and collaboration with practitioners in a context. Educational design research reduces the “credibility gap” between research and practice (DBRC, 2003, p. 5), and is more likely to be socially responsible (Reeves, 2000). In educational design research, each iterative cycle leads to insights that generate adjustments for the next experiment.

MacDonald (2008) recommends using educational design research for investigating the effectiveness of learning communities in developing information communication technology integration practices. The researcher states that educational design research “fits very well with a community of practice as both are designed to respond to the ever-changing reality of messy educational settings” (MacDonald, 2008, p. 433). Educational design research and learning communities both create solutions to problems in an iterative fashion. MacDonald stresses the importance of teacher and researcher goal-alignment and needing a consensus on who will decide any changes made to research goals and design.

Research Context

Any lived experience can best be understood in context (Marton, 1981). The context for this study is a rapid design practice field developed through an event called “thinc-a-thon." Thinc-a-thon uses a rapid design activity to foster project and business building among students in interdisciplinary teams.

Program description. The context for this study is a community of innovation created through the development of an interdisciplinary rapid design event. The event is called “thinc-a-thon" to align with the *Thinc at UGA* initiative which seeks to promote entrepreneurship and innovation on campus ("Thinc. | The Spirit of Entrepreneurship at UGA," n.d.). Thinc-a-thon is not connected with any class or curriculum, so students do not receive credit for participation.

People. Thinc-a-thon events are open to students from all disciplines and levels, but are specifically promoted to students in fields related to business, science, engineering, art, and technology. These events are designed to attract students interested in starting a business now or after graduation, but they are also meant to attract a mix of what Graham (2014) describes as "career focused students" and "subject focused students." Career-focused students are only likely to engage in an activity if they see how it can improve their employability, while subject-focused students have deep disciplinary knowledge. Career-focused students use this type of event to add project experience to their resumes, and subject-focused students seek to practice their skills and increase their knowledge.

I constructed the teams on the day of the event to encourage interdisciplinary collaboration. Ideally, each team contained one or two technical students, one design or art student, and one business student or a student from a different major (acting as a subject-matter expert). Students were not allowed to construct their own teams, since this would have likely led to teams whose participants all came from the same major. However, participants could request a maximum of one team member from their own major and two from different majors. I set the maximum number of students on each team at five, since larger teams can lead to communication and coordination issues and lack of cohesion (Blau, 1970; Shaw, 1976).

Place. The event took place in multiple locations on campus, including a collaborative learning space in the main library and the university student learning center. Beginning with the second iteration, I was also able to offer access to a makerspace in the science library. These spaces are areas where students from all disciplines have access and feel comfortable. They provide structures for students to work together in teams, but they also make it easy for participants to leave and re-enter the space as necessary.

Program. I structured the event to contain a variety of elements that would ensure an authentic rapid design experience. I also integrated challenge-based learning in the design: each event focused on the challenge of analyzing and improving various life experiences – for example, the challenge of redesigning transportation, a shopping experience, or a board game. The teams were expected to develop a prototype of their idea using the resources provided during the event (e.g., speed of though materials, makerspace). An example of the tools provided at every event can be found in Figure 3. I held the pilot study event on a Friday evening for three hours and the following Saturday for ten hours. I increased the duration of the second iteration to 32 consecutive hours from a Saturday morning to the next Sunday afternoon.

Throughout the event, I offered one-hour popup classes, defined as quick, just-in-time-learning classes, about mindfulness, business pitching, and prototyping taught by local entrepreneurs. I did not require every member from each team to attend every class. Participants only went to classes that personally interested them; that way, the teams could continually make progress on their project throughout the event.

During the event, mentors from startups and technology businesses made themselves available to meet with teams for a two-hour span through Google Hangout. Teams could sign up for a fifteen-minute session with the mentors during that two-hour span. Participants shared their projects and ideas with the mentors, and the mentors gave feedback on business viability and direction. Professionals from local organizations also provided mentoring during the event by walking around to each team, listening to the teams' ideas, and offering feedback.

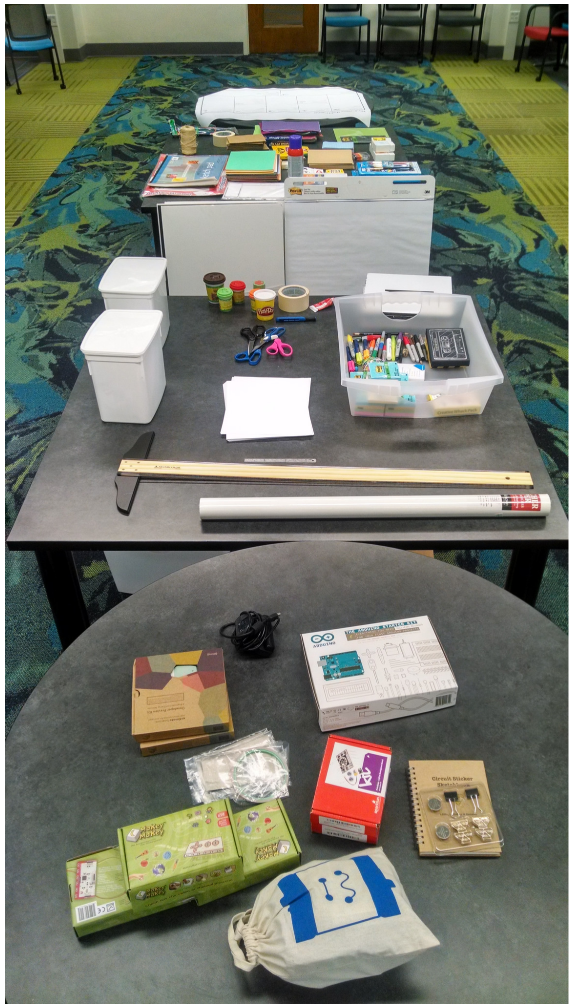


Figure 3. Tools commonly used during the thinc-a-thon events.

These mentor-participant interactions provided a temporary cognitive apprenticeship for students, so they could see how real designers and entrepreneurs rationalize their decisions. I used a card game instead of lectures to teach participants about the design and entrepreneurship process. Each card listed a specific task related to design or entrepreneurship. Teams collected points by completing tasks and submitting proof to me electronically. The card game gave the teams a scaffold for the steps they would need to take to successfully design and build a business. However, the cards did not make apparent the proper order of the steps. Point levels gave clues about the relative importance of each task, but the teams had to decide for themselves in what order to complete the tasks.

Professionals from local organizations served as judges for the event. The judges evaluated which teams' ideas had the most potential, and the winning teams received prizes and resources. The purpose of the prizes was to encourage teams to continue their projects after the conclusion of the event. All prizes and resources were provided by the university's Office of the Vice President for Research.

Educational Design Research Procedure

McKenney and Reeves (2012) proposed a basic model for conducting educational design research. This model consists of three micro-cycles; analysis and exploration, design and construction, and evaluation and reflection. In the analysis and exploration stage, researchers conduct a literature review and foster collaboration with practitioners to get a better understanding of the problem, context, and stakeholder needs to develop "a scientifically relevant angle for the study, where the problem in question can be seen as a particular instance of a research-worthy phenomenon" (p.79). In the design and construction stage, researchers draw on theory and practical considerations to generate an initial design framework with principles. Finally, in the evaluation and reflection stage, researchers test the intervention, reflect on the results, and confirm or refine the principles from the design framework. This research model is designed to be iterative and flexible, so that each stage can influence subsequent stages and so that over time, the interaction between research and practice can increase. The research model is designed to generate "maturing interventions and theoretical understanding" (McKenney & Reeves, 2012, p. 80).

Figure 4 shows how I used this model to inform multiple iterations of this research over a two-year period. I began by reviewing the literature on situated learning and informal learning environments to develop a theoretical and conceptual framework. I explored the topic by conducting interviews with informal design activity practitioners. I then developed an environment to test the viability of the event. Based on these findings, I developed design principles that I then refined over two iterations. This project consists of eight micro-cycles, defined as any time one of the three phases began, and two meso-cycles, defined as cycles that contained multiple phases but not the complete design research process (McKenney & Reeves, 2012). The sections below describe each stage of the design research in more detail.

Analysis and Exploration (Fall 2013 – Summer 2014)

In educational design research, the design of the intervention is determined by participant expertise, literature, and field testing (McKenney & Reeves, 2012). In addition reviewing the relevant literature, and developing a theoretical and conceptual framework, I conducted a study (with IRB approval) consisting of interviews with event organizers of a diverse range of temporary extracurricular activities. The purpose of the interviews was to gain insights on how events that fit my conceptual framework were currently being organized in higher education. I questioned interviewees about what inspired and motivated them to organize an event, the design, structure, and promotion of the event, and any outcomes, feedback, or changes they made after the conclusion of their initial event.

Participants. I used word of mouth and Internet searches to identify participants. I used e-mail to contact candidates and schedule interviews. I interviewed three faculty members, one staff member, and one student, all of whom had previously helped organize popup classes, boot camps, and make-a-thons were interviewed.

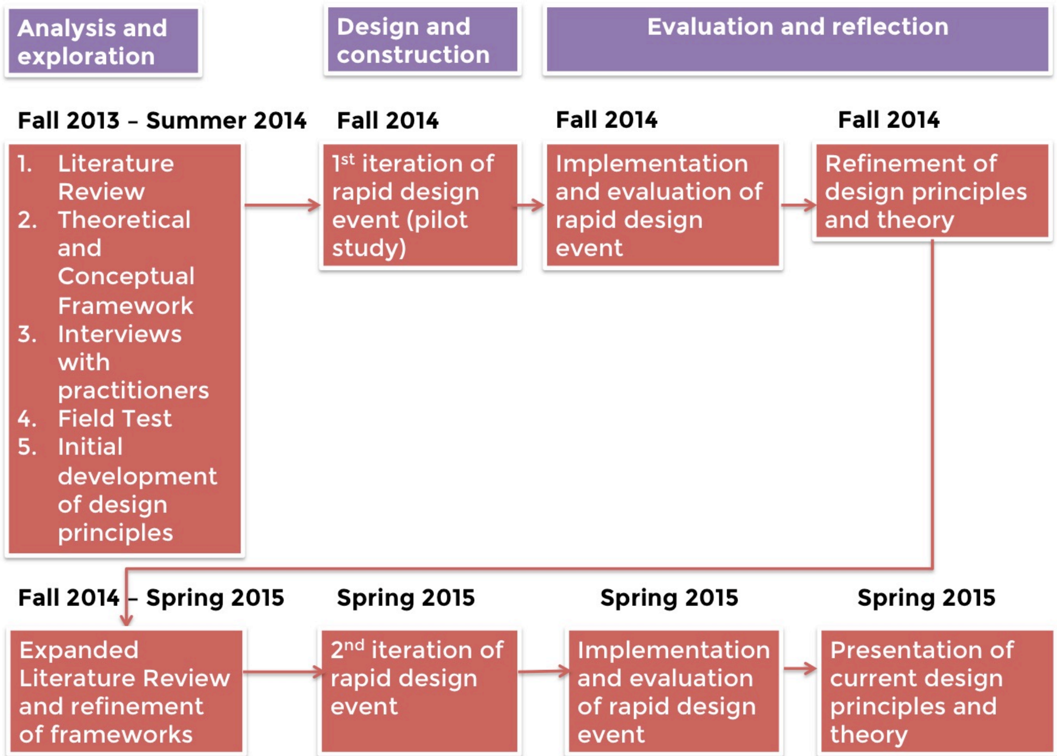


Figure 4. Educational design research approach for project

Design. The interviews lasted 30 minutes and took place either in person or online using Google Hangouts. The structure of the interviews was open, and I designed them to help me learn about the experience of organizing these activities. Participants gave IRB consent before the interviews began. This process helped develop a network of "critical friends" that assisted in informing the design and research of the learning environment I used in the pilot study of the research (McKenney & Reeves, 2012). I used a grounded theory approach to analyze the transcriptions of the interview transcripts (Charmaz, 2006). Three themes characterized every type of informal environment: participants described the informal environment as a playground for instructors, a space for students to struggle and take risks, and a platform that enabled students to learn the design process inductively.

Findings. Three themes emerged from the analysis of the interviews.

Informal learning as a playground for instructors. Many of the organizers said that their informal environment offered the opportunity to try out instructional techniques before implementing them in a traditional classroom. They experimented most often with content, instruction, assessment, and the physical space. They indicated that organizers can take more risks in an informal environment and do not need as much institutional support. Instructors said that often, when an experimental instructional technique was successful in the informal setting, they would then implement it in their traditional classes.

A space for students to struggle and take risks. In a traditional classroom, students are primarily concerned with receiving a passing grade. This concern can lead students to take the easiest path to success and to adopt a cautious and conventional mindset. This mindset can limit the knowledge students can gain in a class. Informal learning environments provide an opportunity for students to take risks and learn through failure without fear of receiving a low grade. Productive failure prepares students for future successes (Kapur, 2008). The open environment in these informal settings encourages students to be creative, which engages them in deeper learning. The less instruction given, the more students are empowered to leave their comfort zone to progress through a project.

A platform for learning design thinking inductively. Rather than using extended lectures and examples to explicitly lead the students through the design thinking process, many organizers allowed students to struggle through the process. One organizer remarked:

> It's better for students to learn through doing than telling so I prefer to just launch them into their projects and have them struggle along and guide them throughout

with small bites of information that can sink in quickly rather than going on like a one-hour-long lecture rampage.

Discussion. These themes, along with the conceptual framework, served as inspiration for developing the informal rapid design activities. Interview participants emphasized fostering openness and providing opportunities for students to get out of their comfortable zones. These experiences are appealing to students, which overcomes the lack of curriculum credit. The insights I derived from interviews with organizers are consistent with the theories that inform this study, including constructivism, experiential learning, and situativity theory. I created a logic model to visualize the structure of the thinc-a-thon event. A logic model consists of planned work and intended results (*Logic Model Development Guide*, 1998). Planned work includes resources and activities for the program implementation. Intended results are the expected outputs, outcomes, and impacts of the planned work. Figure 5 displays the logic model for the thinc-a-thon event. One high-level conjecture is that combining students from diverse disciplines with a creative space and situated scaffolding tools (e.g., participation in the card game, interaction with mentors, and popup classes) can lead to not only real practice emulation and contributions to the fields of design and innovation, but also the formation of a community of innovation. Through the process of interdisciplinary rapid design activity, students begin to develop into T-shaped professionals. This process is facilitated through activities such as situated design, interdisciplinary collaboration, and the process of finding and solving problems. Students who participate in these activities engage in developing a shared objective, developing team and individual innovation strategies, and creating new prototypes and business models.

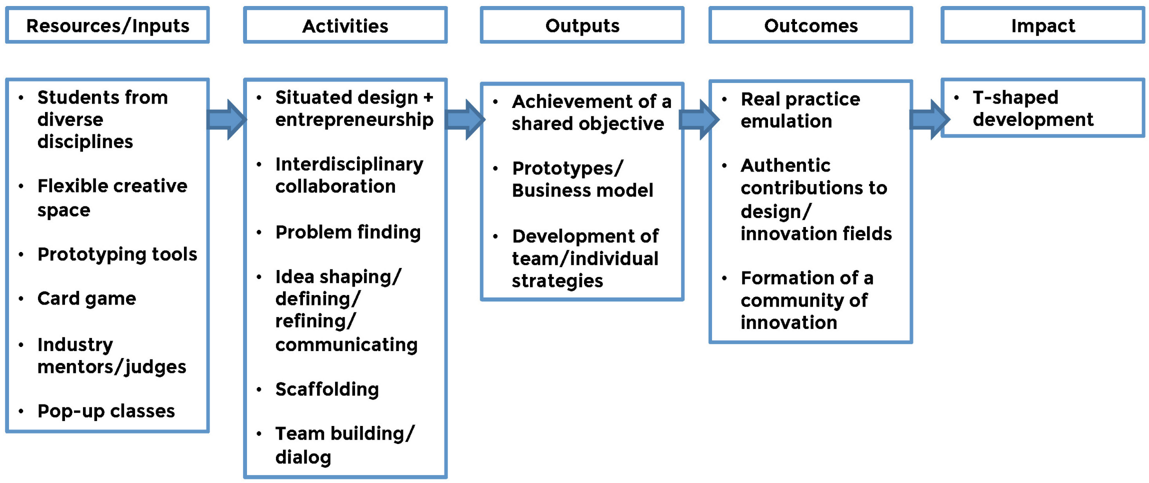


Figure 5. Logic map for thinc-a-thon event

This conjecture is derived from combining the concepts of situated-based learning (creating an authentic learning experience) and practice fields (equipped with the necessary scaffolds and resources) with community development (specifically communities of innovation).

Field Test

In March of 2014, as part of the analysis and exploration stage, I organized a rapid design event to test its viability in a higher education setting. The chosen challenge was "redesigning the home." I advertised the event through flyers (example found in Appendix A), social networks, word of mouth, and presentations in classes and club meetings. The event took place in a reserved room in the university student learning center. Students who participated in the event spent the day designing solutions to make the home more usable, efficient, and fun. The eleven students who participated in the challenge had backgrounds in engineering, art, business, and journalism. I placed them into three teams, each of which used the eight-hour time frame to create a prototype related to the topic.

Throughout the day, the participants engaged in activities to encourage empathy, brainstorming, customer development, and rapid prototyping. An instructor held a special session on mindfulness, during which he led students in a meditation exercise. At the conclusion of the event, which lasted eight hours, the teams presented their projects. Example projects included a smart refrigerator that would track inventory and offer recipe suggestions, a house that generates energy from the walking or running done inside it, and a lighting system that adjusts the position and intensity of the lights in the house based on the time of day and the position of house's occupants. Students voted on their favorite idea of the event (e.g., the energy-generating house) and received only small, non-monetary prizes. While I did not conduct a formal empirical study of student engagement in the challenge, I informally observed that participants were highly engaged. Two of the participants attended the next two events I organized. According to participants' informal report, completion of the challenge gave them a greater sense of their skills and potential as innovators and gave them insight into how design collaboration works.

Design and Construction (Fall 2014): Thinc-a-thon Pilot Study

The thinc-a-thon pilot study event (the first iteration of the design research process) took place in September 2014. Participants were challenged to develop solutions to improve the student experience. Teams could choose from a variety of topics, including campus food, transportation, housing, social life, or the classroom. I advertised this event using the same strategies I used to advertise the viability event. The event was extended from eight hours to thirteen hours to provide more time for students to work on their projects. Thirty-eight students from engineering, science, art, design, and business attended the event. Five students dropped out before the end of the event. Due to no-shows and dropouts, some teams only had two or three members.

Table 2 displays the initial design principles I used to structure the event. I constructed the design principles using concepts from experiential and situated-based learning, and strategies from design activity organizers. To provide a more authentic design environment while also scaffolding the design and entrepreneurship process, I added many elements during the pilot study.

I introduced a card game to guide teams through the design and entrepreneurship process. Design activities have sometimes used cards as a source of inspiration (Carneiro, Lago, & Paulo, 2011; IDEO, 2003; Miemis, 2012; "The Bootcamp Bootleg," n.d.). In this card game, each card listed a task, and teams received points for completed tasks. Some cards featured a quick response (QR) code that offered access to more resources. Teams could scan the QR code with an electronic device (e.g., phone, tablet, laptop, etc.) and receive a link to a Web page related to the task. Web pages contained articles and tools that were useful for completing the given task. Different tasks were associated with five point levels such that teams earned more points for completing tasks that were more important to the design thinking process, or that required more in-depth work. Appendix B lists all tasks featured in the game. To provide an incentive for the teams to participate in the card game, $400 of startup seed funding was budgeted to give to the team that had the most points at the end of the event.

Throughout the day, I offered popup classes on various topics related to design and entrepreneurship including mindfulness, business pitching, and prototyping. Teams also had the opportunity to sign up for 15-minute meetings through Google Hangouts with alumni who worked for relevant companies (e.g., Google) or had started their own venture. Once connected, teams were able to share their business ideas and receive feedback on viability and development.

Table 2.

Design principles and strategies used for the pilot study

Principles	Strategies	Theory/Evidence
	People	
Promote diversity, community, and team cohesion	• Create interdisciplinary teams with a diverse set of skills	• Diverse groups are more innovative (De Dreu & West, 2001) • Communities of innovation (West, 2009)
	Place	
Encourage the use of creative spaces	• Host event in collaborative space in the library	• Flexible learning spaces (Kim & Mcnair, 2009) • Spaces for innovation (McIntosh, 2010) • Third spaces (Santasiero, 2002)
	Program	
Provide multiple opportunities for teams to receive feedback on ideas	• 15 minute sessions with mentors • Teams present to and receive feedback from judges	• Cognitive apprenticeship (Collins, Brown, & Newman, 1989)
Maximize the success rate for participants new to rapid design activities	• Create a card game designed to teach students how to navigate the design and entrepreneurship process • Provide popup classes on various related topics	• Experts provide scaffolding and coaching (Singer, Nielsen, & Schweingruber, 2012)
Provide opportunities for participants to solve open and ill-defined problems	• Teams must create a new project or service that solves a problem within the given challenge	• Challenge-based learning (Johnson, Smith, Smythe, & Varone, 2009)
Provide resources to facilitate the continuation of projects after the event	• Funding given to projects with the most potential	• Prizes build communities of innovators (Goldhammer, 2014)

Figure 6 shows some of the cards used in the game. To receive points, teams e-mailed a picture or video providing proof that they had completed the task correctly.

Figure 6. Cards used in the design and entrepreneurship process game

This event took place in a flexible study space in the campus library. Figure 7 shows the portion of the library space used for the event. The walls of the space were covered with whiteboard paint, allowing for drawing and writing, and the tables and chairs could be easily be moved around within the space. Compared with the room in the university learning center that was used for the pilot study, this space was more consistent with the coworking and creative spaces that professionals use for rapid design activity.

To increase motivation and participation, I announced before the event that the winning team would receive funding to join the university's annual Silicon Valley trip to meet with entrepreneurs and venture capitalists, as well as a four-month membership to a local student incubator. Goldhammer (2014) mentions that "prizes are not simply a means to crown a winner, but a powerful and successful approach to building a community of innovators focused on pressing societal issues" (para. 1). I asked entrepreneurs in the community to serve as judges to choose the winners of the prizes. Judges evaluated teams according to the following four criteria (weighed equally): business model (e.g., can the idea make money?), customer validation (e.g., did the team identify customers and get out and talk to them?), technical (e.g., is there a functional product or in-depth prototype?), and design (e.g., does the idea deliver a captivating and memorable user experience?). The judges picked a team that created a device called *Pedal* that, when paired with a mobile application, could allow students to rent bikes on campus. Other projects included a mobile application for determining the number of spaces remaining in the parking decks on campus; a low-power digital board at bus stops for displaying real-time bus information, news, and relevant events; and a mobile application for helping students find recipes that use ingredients they already have at home.

Evaluation and Reflection (Fall 2014)

In this iteration of the study, in addition to developing design principles, I sought to answer the following questions:

- What attributes of the practice field do students find engaging?
- How can the practice field support the continuation of projects beyond the event?

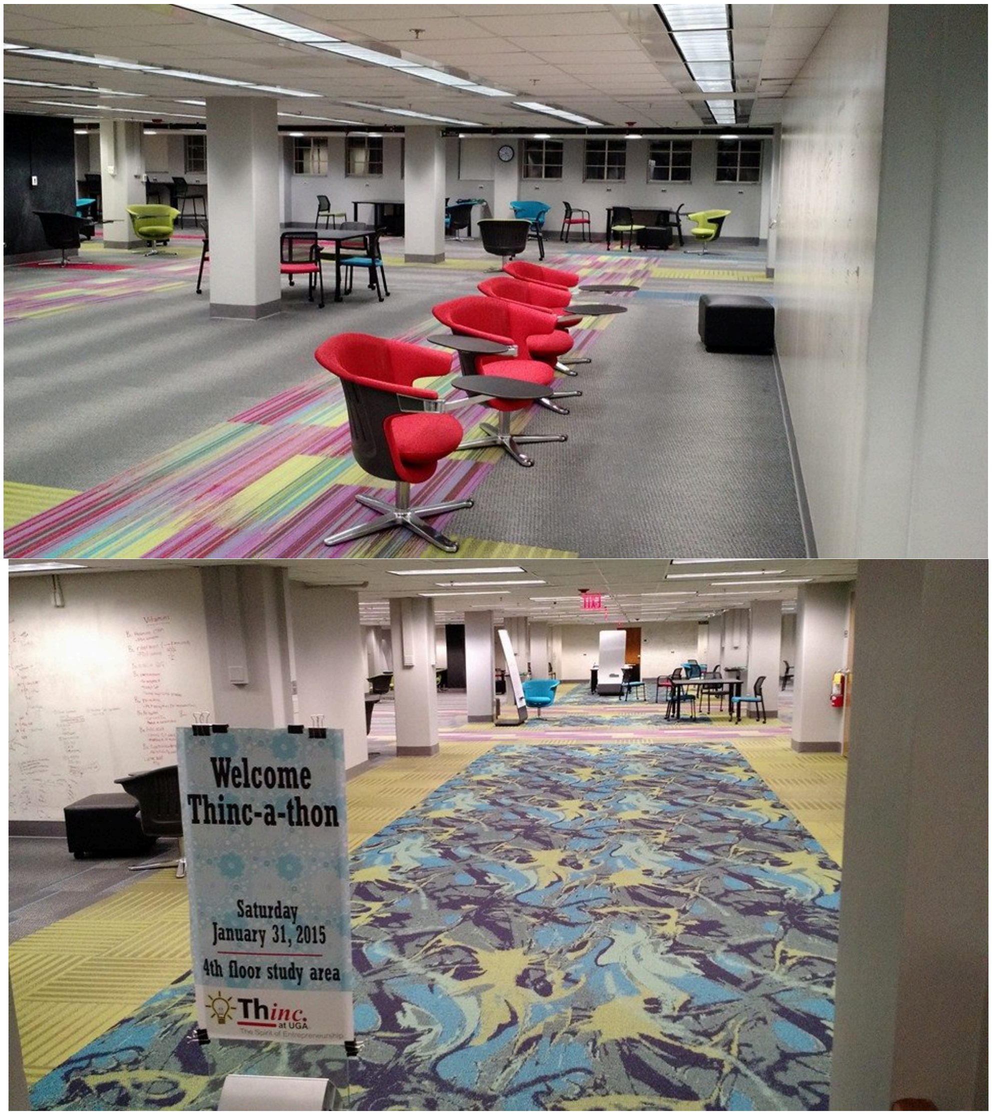


Figure 7. Flexible creative space in the library used for the event

When conducting design research, data gathering can be extensive and overwhelming (A. Brown, 1992; Dede, 2004). This study made use of two data collection methods: surveys and interviews. Table 3 presents the study's research questions and their corresponding methods of data collection and analysis.

Data collection: Surveys. Before teams presented their projects to the judges, students were given the opportunity to complete a survey about their experience participating in the event. Students could also complete the survey after the event was over. The survey captured demographic information about the students and their reasons for attending the event. The survey used a 5-point Likert scale for participants to rate their views on collaboration, their satisfaction and frustration with the event (Rogers, 2012), and the effectiveness of the card game and overall event. The surveys also had open-ended questions that asked about moments the participant enjoyed and found inspiring (Rogers, 2012), how the event altered their view of their or their team members' disciplines, and what skills they began to develop by participating in the event. The complete survey appears in Appendix C.

Table 3.

Research questions and methods for pilot study

Research Question	Data Type	Data Source	Analysis Procedure
What design principles can be derived from the development of an informal design and entrepreneurship event? (overarching question)	Qualitative/ Quantitative	Surveys Interviews	Descriptive statistics Grounded theory
What attributes of the practice field do students find engaging?	Qualitative/ Quantitative	Surveys Interviews	Descriptive statistics Grounded theory
How can the practice field support the continuation of projects beyond the event?	Qualitative/ Quantitative	Surveys Interviews	Descriptive statistics Grounded theory

I used descriptive statistics to analyze the survey data. Out of the 33 students that completed the event, 30 students participated in the survey (four of these were not completely finished). A total of 53% of survey participants were women and 47% were men. Three participants were graduate students. Tables 4 and 5 display the breakdown of survey participants by discipline and year in school.

Data collection: Interviews. I conducted one-on-one semi-structured interviews with ten participants to get a more in-depth understanding of their experience. I interviewed five men and five women. Six of the interviewees were from engineering or science majors, two were from art or design majors, one was a business major, and one majored in human development. I used an open-ended approach for the interviews that focused on "why" questions as opposed to traditional "what" questions. I asked participants an initial question, and then asked follow-up questions. I based the follow-up questions on statements the participants had made in their answers to previous questions (Mann, Alba, & Radcliffe, 2007).

Table 4

Number of Survey Participants by Discipline

Discipline	Number	Percentage of Whole
Engineering/Computer Science	13	43.3%
Science	3	10.0%
Art/Design	8	26.7%
Business	5	16.7%
Other	1	3.3%
Total	30	

Table 5

Number of Survey Participants by Year in School

Year	Number	Percent of Whole
1st Year	2	6.7%
2nd Year	7	23.3%
3rd Year	12	40.0%
4th Year	6	20.0%
5th Year +	3	10.0%
Total	30	

I specifically encouraged participants to discuss their experiences collaborating with students outside their disciplines, the team process that developed, any conflicts they encountered, and how they had resolved those conflicts. Participants also had the opportunity to expand upon their responses from the survey, especially relating to moments that brought enjoyment and inspiration, their experience with the card game, and skills they learned from participating in the event. The interview guide can be found in Appendix D.

An outside source transcribed the interviews. To identify patterns and themes in the data, I used the grounded theory approach to analyze the transcripts. Grounded theory, a widely used qualitative method, moves beyond describing a phenomenon to generate a theory of participant behavior based on the data (Charmaz, 2006). Using grounded theory, researchers can closely oversee the research process and gain the analytic power necessary to discover interesting patterns in the data (Charmaz, 2006). Mayan (2009) proposes that “the only way in which everyday social life and theory can be closely related is if theories are induced from the data” (p. 47). Instead of searching the data for preconceived themes, researchers uncover themes that emerge organically. I used NVivo to code the interviews, and formed those codes into broader categories to advance conceptual understanding (Charmaz, 2006). There were a total of 17 codes. I then used constant comparison techniques to discover patterns and overlaps. The codes were categorized as “people,” “place,” or “program” to correspond with the community of innovation framework. These categories were chosen to connect with the design principles categorized under the same elements. An example of how NVivo was used for the coding and category process in the pilot study is found in Figure 8.

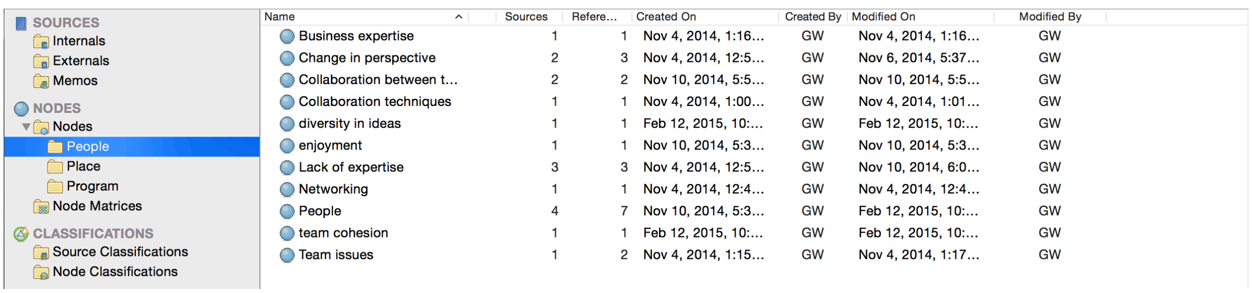


Figure 8. Categories and codes derived from pilot study interviews using NVivo

Findings. *What attributes of the practice field do students find engaging (especially students that aren’t pursuing entrepreneurship)?*

The quantitative and qualitative data both confirmed that elements of the people, place, and program framework engaged students in the entrepreneurship practice field. Table 6 summarizes the survey data on participants’ characteristics, and Table 7 summarizes the results of the Likert questions.

People. Nearly all of the students (97%) enjoyed collaborating with students from different disciplines, and wished there were more opportunities on campus to do so (93%). The event succeeded at attracting a wide variety of students. One of the goals of the event was to attract students who had not previously participated in a make-a-thon or hack-a-thon and were not interested in starting a business and expose these students to design activities. I accomplished this goal: 87% of participants were attending this type of event for the first time, and only 10% of the participants planned to start a business after graduation. Most of the students attended the event because they were interested in the topic (87%), wanted to practice design (57%), and/or wanted to collaborate with others (70%).

Many of the participants (80%) said that the event had altered their view of their major or their teammates' majors. When asked why, most participants said that they had gained a new perspective by working with students with different mindsets.

Participants also reported an increased awareness of other disciplines through responses such as "I did not know how cool computer science was," "I just have more respect for design and business majors," and "business majors are also artistic".

During an interview, one participant mentioned being pleasantly surprised by the number of women at the event because she perceived the business and technology fields as "male-dominated". Another interviewee, who was a graduate student, mentioned being inspired by a younger teammate because the student "had so many good ideas, fresh ideas."

The most common challenges teams encountered were missing expertise due to a missing student from their team. The teams met this challenge by using online resources and assistance from the mentors. The length of the event may have been too short for any major conflicts to occur. The small team size may also have contributed to the lack of conflict. The relative lack of conflict could be partly attributable to the fact that students' participation was voluntarily, rather than a class requirement (Khorbotly & Al-Olimat, 2010).

Place. Six survey respondents indicated that interacting in the physical environment was an element of the event that brought enjoyment and inspiration. Many interviewees described using the writable walls for brainstorming and team planning. The open space in the library helped foster community among the teams despite the competition structure. As one interviewee said, "All the groups were near each other and we could easily go and talk with them and see what they were doing, and having, like, the 3D printer next to us, and even though we didn't use those things, just seeing it and being exposed to it, that type of environment was really nice, the openness of it all."

Table 6.

Participant characteristics from survey responses

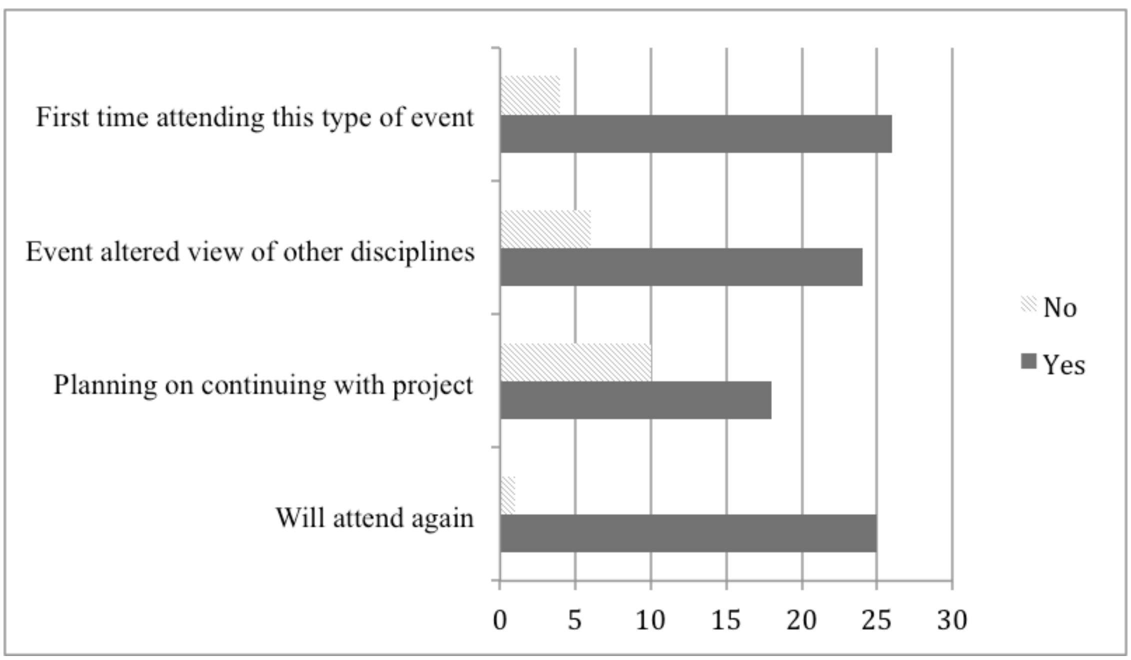


Table 7.

Survey results from Likert questions

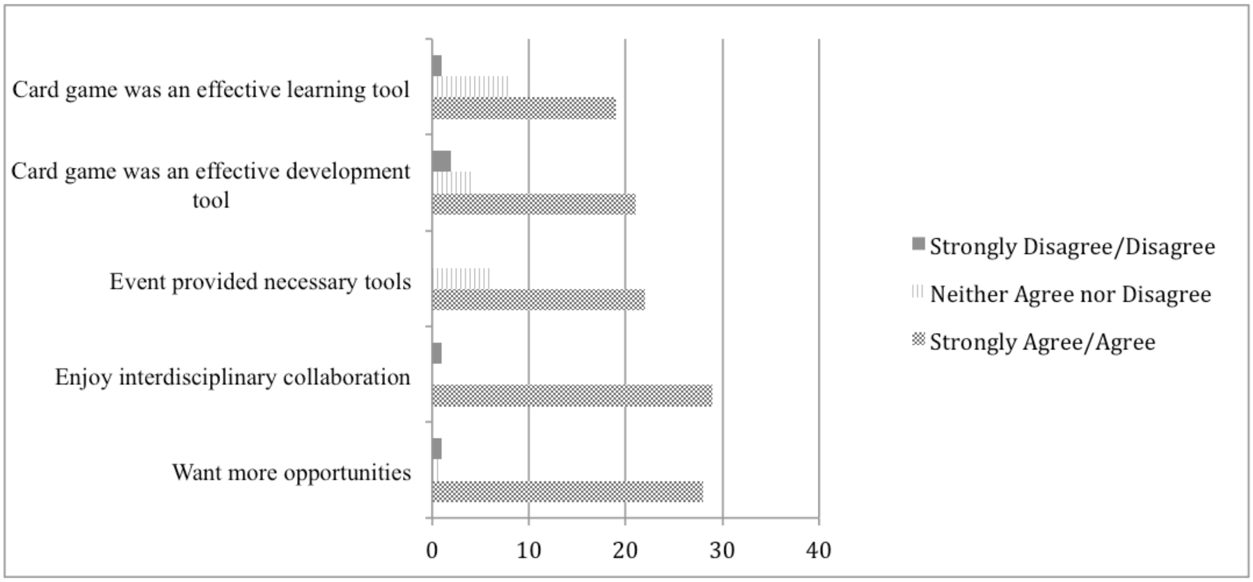
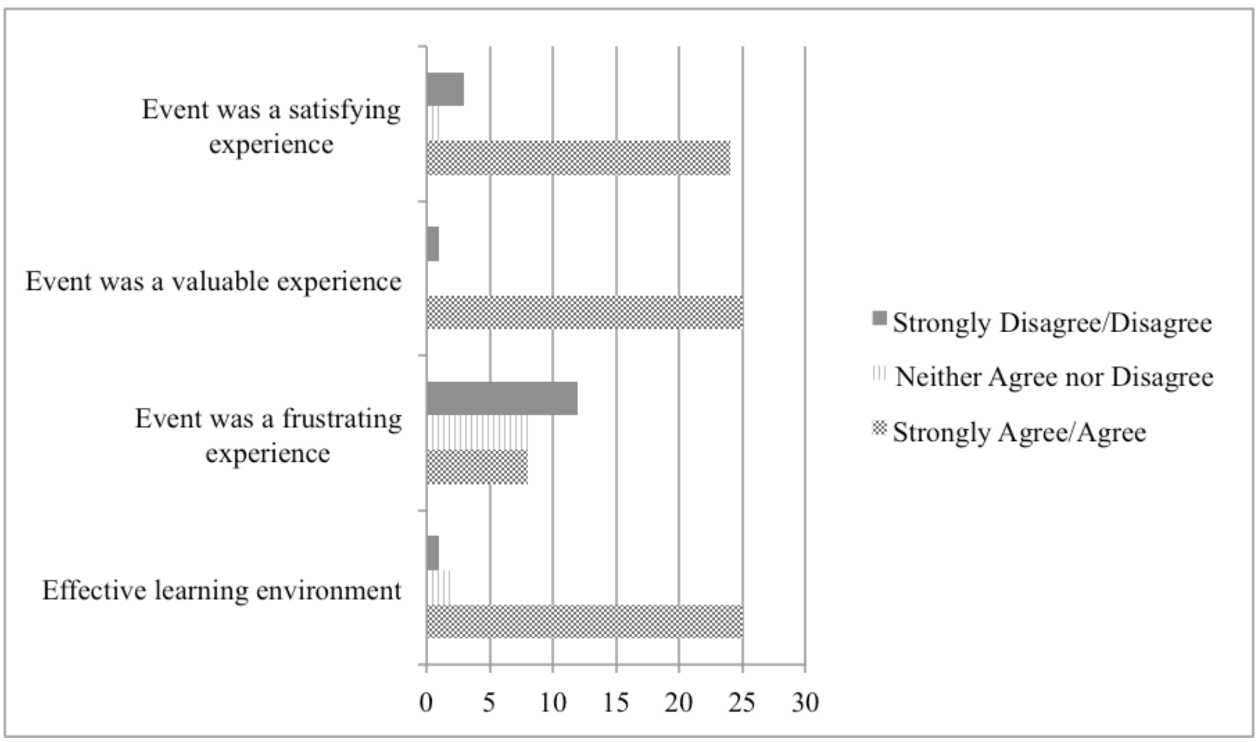


Table 7.

Survey results from Likert questions (continued.)



Program. Additional elements of the event that survey respondents found engaging were team accomplishments and interactions (15 respondents), the mindfulness session (eight respondents), working with mentors or learning from popup classes (six respondents), interaction in the overall community (six respondents), participating in ideation (four respondents), and a sense of individual accomplishments (three respondents).

The card game successfully provided resources that students could use to learn design thinking without lecturing. A total of 72.4% of participants felt the card game helped their team utilize design thinking tools (three participants did not respond to this question) while 65.5% of participants felt that it helped them learn more about design thinking (two participants did not respond to this question). In addition, students felt that they had learned many skills that they had not learned in their classes (83%, two participants did not respond to this question). Student responses about skills they began to develop by participating in the event fell into five categories: communication (four respondents), entrepreneurship (eight respondents), collaboration (seven respondents), creativity (two respondents), and technical (two respondents).

How can the practice field support the continuation of projects beyond the event?

The survey results show that this type of event can help students think beyond the classroom and approach projects not only as assignments designed to earn a good grade but also as the beginnings of businesses they could start. A total of 60% of participants planned to continue working on their project after the event (two participants did not answer this question). A member from the winning team said that the team had begun meeting weekly, and the participant had personally met with the founder of a local incubator to receive advice on next steps. Advocates of developing an entrepreneurial mindset in students stress that projects should be pushed past being good enough to publish a paper or get a good grade (Carryer, n.d.). Even if ventures ultimately fails, students learn from the experience of attempting to launch a business and improve their odds of succeeding in their next endeavor (Minniti & Bygrave, 2001). Students who were not planning to continue their project cited an inability to find the correct people with the necessary skill, and a lack of interest from other team members. These results demonstrate a need to develop resources to help students in find new team members after the event. Some interviewees mentioned that their team intended to reunite at upcoming design events to work on new ideas.

Design discussion. The most common feedback from students was a desire for the event to have been longer. They wanted more time to develop their ideas and build more detailed prototypes. The common suggestion was to extend the event through Sunday (it originally started Friday evening and ended Saturday evening). The lack of time could have also contributed to the judges' opinions that the teams generally did not spend enough time on vetting their ideas with real customers. In addition to increasing the length of the event, the card game could be modified to focus more on customer development. Some tasks related to customer development (e.g., interviewing and surveying potential customers), but the points associated with these tasks were minimal. The card game could offer more opportunities for customer development and give more points for completing these tasks.

Another issue that was uncovered during the event was the high dropout rate before and at the beginning of the event. While 33 people participated in the entire event, 69 people originally registered. Prior to the event, 16 people canceled, and there were 15 no-shows at the beginning of the event. Five people also did not return for the second day. While I expected cancellations, the high number of no-shows caused team construction issues. Before the event, I had arranged participants into teams equipped with three or four students from diverse fields, so the no-shows and dropouts meant that some teams had to either combine with other teams or make do with only two students. The most common obstacle that teams reported encountering was lack of expertise. The high no-show rate also created budget issues regarding food preparation. To counter this issue, organizers could create an application process or institute a small fee to ensure that students will only sign up if they are committed to attend.

Revising design principles. This section discusses each design principle and its influence on the event.

1) Promote diversity, community, and team cohesion

Results show that participants enjoyed working in diverse teams. Teams created cohesion by discussing similar interests and finding common ground, and the structure of the event gave them opportunity to do this. Once teams are formed, early activities should have the goal of promoting conversation among the team members. One issue with forming teams before the event is the possibility of creating short-handed teams if some participants register but do not attend. It is better to form teams once all the participants have arrived at the event. While participants created community within their teams, I recommend creating structures that encourage community among all the participants in the event. Organizers could create more activities to foster interactions among participants even before the event. These pre-event activities might also help reduce the number of no-shows, since they would enable students to become a part of the community before the event.

2) Provide multiple opportunities for teams to receive feedback on ideas

In the survey and interviews given after the end of the event, many participants mentioned that interacting with the popup class instructors and team mentors was a highlight of the event. The instructors and mentors were able to provide feedback on par with the type of advice professionals give one another in industry. This increased participants' confidence in their work. For example, one participant said:

> "Something that has been inspiring has been…we were talking with [Google employee] and she was just all for the idea and that was really, really encouraging. It kind of gave us a little kick to keep working hard at it and get it finished rather than just kind of sitting around, "Well, this is good enough. [We were able to trust] the experience that she had too. Of course, Google is a very credible name."

3) Maximize the success rate for participants new to rapid design activities

Results from the survey show that the card game was a success. Most of the teams participated in the card game. A member of one of the teams that did not have many points in the end said that the team had completed many of the card tasks, but did not take the time to submit them for points. Results were also favorable for the popup classes.

The judges commented that they felt that the teams had not focused enough on customer development and that this affected the quality of the solutions. Many of the game's customer development cards (with tasks such as interviewing and surveying potential customers) were low-level cards. The lack of points could have led teams to not take these tasks seriously. Many teams completed these tasks but did not put much detailed thought into them.

4) Provide opportunities for participants to solve open and ill-defined problems

At the beginning of the event, I presented the participants with the topic "improving the college experience" and gave examples of existing technologies that had improved the college experience (e.g., Facebook, ClassGet, Ninja Courses). The openness of the challenge allowed the teams to choose from among a variety of problems.

After using the card game and general brainstorming to search for a problem, the teams focused on the problems in transportation, food, networking, and tutoring.

5) Encourage the use of creative spaces

Many participants said that the creative space in the library motivated them and assisted in the team process. The space successfully provided an open environment that facilitated ideation and innovation.

6) Provide resources to facilitate the continuation of projects after the event

Both the team that the judges decided had the most potential and the team that had earned the most points in the card game used their funds to join the local student incubator. By participating in the incubator, the students were able to join a community of student entrepreneurs and receive mentorship from local startups. During the development process, students also developed empathy and support for their peers. Some teams, including the winning team, took on new members and decided to work on different ideas. Overall, students who participated in the event were confident in their ability to compete at future events.

Analysis and Exploration (Fall 2014 – Spring 2015)

During this phase, I expanded the literature review to include a deeper analysis of communities of practice and examples of informal design activities and experiential learning theory. I conducted an informal interview with a rapid design activity practitioner to receive advice on how to improve the event. The practitioner offered advice such as targeting specific students for participation to counter dropouts and ensure the participants who attend are engaged and passionate about the process. She also recommended fostering a sense community and engagement before the event by creating a social media platform where participants can share relevant articles, images, and inspirations.

During this phase, I decided to investigate how teams form communities of innovation during this event, how the scaffolds (card game, mentors, popup classes) influence the communities, the challenges these communities encounter, and how they overcome them. These research questions were influenced by the findings from the surveys and interviews that focused on the experience of the participants being a part of a team during the event. As shown in Table 8, the participants had positive interactions within their teams and these interactions influenced their outlook on their field of study and their teammates' field of study. It was also necessary to further investigate the challenges teams encountered during the event as not many challenges were uncovered in-depth during the pilot study. Many participants discussed a lack of conflict during the event, so it was necessary to investigate how the teams were able to avoid conflict.

Design and Construction (Spring 2015)

The second iteration of the event took place in January 2015. The event's challenge was centered on designing for food and health. Projects could involve creating a new food or health business or systems, designing for food sustainability, or social application related to dining. The event ran for 32 consecutive hours from a Saturday morning to Sunday evening. Table 9 displays the revised design principles I used to structure the event. I took the advice of the rapid design event practitioner that I had consulted and set up a Facebook event page for participants to connect with one another, share ideas, and gain inspiration before the event. The organizers also shared examples of products and services to facilitate discussion. To lessen the chance of uneven teams due to dropouts, I constructed the teams at the beginning of the event. The goal remained the same: to have interdisciplinary teams made up of four or five members.

Table 8.

Additional research questions for second iteration that emerged from the results of the pilot study

New research questions focused on communities of innovation	Results from pilot study (iteration 1)
How can communities of innovation form during rapid situated design activities?	• A total of 97% of the participants enjoyed collaborating with students from different disciplines. • A total of 93% of the participants wished there were more opportunities on campus to do so. • A total of 80% of the participants had their view of their major or their teammates' major altered • Team accomplishments and interactions received the most codes for responses to engaging elements of the event.
How can just-in-time learning tools facilitate innovation scaffolding in these communities?	• Participants found the scaffolds engaging, but there was not enough data on how the scaffolds influenced the teams.
How can participants in these communities overcome challenges?	• The common challenge reported was missing expertise. • Team cohesion issues or conflicts were not reported

The first activity conducted by the organizers was a T-shaped activity created by u.lab, an innovation lab, (Jakovich & Schweitzer, 2012). In this activity, students gather into their teams; interview their teammates about their disciplinary skills, wider skills, and passions, and write their responses on Post-it notes. Each team then places its notes on a large poster board to create a large "T." Post-it notes related to skills make up the trunk of the T, while passions make up the branch of the T. This activity helps participants learn about teammates' and the overall community capabilities. It also fosters empathy and openness among both the teams and teammates (Jakovich & Schweitzer, 2012).

Table 9.

Design principles and strategies used for the second iteration (new strategies are italicized)

Principles	Strategies
People	
Promote diversity, community, and team cohesion	• Create interdisciplinary teams with a diverse set of skills • *Facilitate the T-shaped activity to encourage discussion* • *Create a Facebook event page for participants to share ideas prior to the event* • *Award card game points for helping other teams*
Place	
Encourage the use of creative spaces	• Host event in collaborative space in the library • *Provide a makerspace for participant use* • *Allow teams the choice of multiple spaces to work in*
Program	
Provide multiple opportunities for teams to receive feedback on ideas	• 15-minute sessions with mentors • Teams present to and receive feedback from judges
Maximize the success rate for participants new to rapid design activities	• Create a card game designed to teach students how to navigate the design and entrepreneurship process • Provide popup classes on various related topics • *Encourage participants to focus more on customer development (card game + popup class)*
Provide opportunities for participants to solve open and ill-defined problems	• Teams must create a new product or service that solves a problem within the given challenge
Provide resources to facilitate the continuation of projects after the event	• Funding to further develop ideas is given to projects with the most potential

Many companies that facilitate rapid design activities, provide access not only to creative spaces for collaboration and ideation, but also to makerspaces or a product realization lab ("Go Inside Google Garage, The Collaborative Workspace That Thrives On Crazy, Creative Ideas," 2014). These spaces allow participants to use advanced tools such as 3-D printers to build quick but complex prototypes. This event facilitated the use of the university library's makerspace, equipped with three 3-D printers, a laser cutter, microcontrollers, and hand tools. Due to space restrictions, teams had to schedule time during the event to use the space. Makerspace facilitators provided training for participants who were unfamiliar with the tools.

To encourage participants to spend more time on customer development, I increased the point values of the card tasks related to this topic, and told participants that their team would only receive those points if they completed those tasks comprehensively. I also created a popup course on customer development taught by a local entrepreneur. A complete schedule of the event can be found in Appendix F.

Evaluation and Reflection (Spring 2015)

In addition to developing design principles for rapid design practice fields, I sought to investigate the following questions:

- How can communities of innovation form during rapid situated design activities?
- How can just-in-time learning tools provide scaffolding to support innovation in these communities?
- How can participants in these communities overcome challenges?

Table 10 presents the study's research questions and their corresponding methods of data collection and analysis.

Table 10.

Research questions and methods for second iteration.

Research Question	Data Type	Data Source	Analysis Procedure
What design principles can be derived from the development of an informal design and entrepreneurship event? (overarching question)	Qualitative/ Quantitative	Surveys Interviews	Descriptive statistics Grounded theory
How can communities of innovation form during rapid situated design activities?	Qualitative	Interviews	Case studies
How can just-in-time learning tools provide scaffolding to support innovation in these communities?	Qualitative	Interviews	Case studies
How can participants in these communities overcome challenges?	Qualitative	Interviews	Case studies

Research Design

I used a case study approach to investigate the development of communities of innovation in a rapid design event. Case study analysis has emerged as an effective tool for design research studies (Hall, 2009; Porcaro, 2011). Case studies seek to address the "how and why" of real-world practices. Case studies should be used when the researcher desires to analyze contextual conditions of the phenomenon being studied, and the boundaries between the context and phenomenon are not apparent (Yin, 2009). A "case," or the primary unit of analysis, can be an individual or some event or entity. For this study, the project development process for each team that participated in the design challenge event was a case; thus I used a multiple-case design. In this kind of design, findings from multiple cases are shared to increase the potential for generalization and robustness (Yin, 2009). Using the multiple-case study approach enables researchers to compare and contrast findings across cases. I interviewed participants from each team to capture descriptions of their experiences. These experiences were complied to form the narrative of each team. Themes and hypotheses are considered secondary to understanding the cases (Stake, 2005). Case studies can be descriptive, exploratory, and explanatory (Yin, 2009). This study focuses on the descriptive aspect of case studies: the primary objective was to describe the phenomenon of the teams participating in the rapid design event, not to test causal propositions or hypotheses. Table 11 lists the teams I used as cases. The judges designated Team Apollo and Team Rock On as the best two teams at the event by the judges. A case study is not a methodology in itself, so it is necessary to pair the case study with methods of analyzing the case (Stake, 2005). To create the cases, I interviewed three out of the four participants in each team, with one exception: I interviewed only two of the five team members of Team Earth. I included this team as a case anyway because the members I interviewed had a different experience from the other two teams, especially regarding team cohesion. In one team only one participant agreed to be interviewed, so I did not use this team as a case.

Data collection methods. To foster information richness and process efficiency (Akker et al., 2006), I used the same data collection methods (i.e., surveys and interview) as I used in the pilot study. However, I altered the surveys to focus more on the effectiveness of the scaffolds used in the event. I specifically asked participants about each situated element including the Facebook group, T-shaped activity, card game, mentors, and popup classes. The survey gauged the participants' opinions on how well these interventions helped them think like a designer or entrepreneur. The survey also gauged the participants' perceived ability in a future design event. The updated survey can be found in Appendix G. The analysis of the survey remained unchanged from the pilot study.

Out of the 27 students that participated in the event, 25 students participated in the survey. A total of 52% of survey participants were men, and 48% were women. A total of 40% of the participants were graduate students, a large increase from the pilot study. Table 12 displays the breakdown of survey participants by discipline. The structure of the interviews was also unchanged. After the event, I conducted nine one-on-one semi structured interviews with participants. I interviewed six women and three men. Six interviewees were students of engineering or science majors. The other three interviewees were students from business, journalism, and consumer foods, respectively.

Analysis. The coding process was conducted in two stages. The first stage consisted of open coding and category formation. The second stage consisted of code comparisons and conclusion generation. I was guided by the modified induction analysis method.

Table 11.

Description of teams used as case-study participants

Name	**Gender**	**Background**	**Interviewed?**
Team Apollo			
John	Male	Arts and Design	Yes
Ethan	Male	Engineering	Yes
Amber	Female	Consumer Foods	Yes
Alan	Male	Business	No
Team RockOn			
Donna	Female	Engineering	Yes
Mandy	Female	Journalism	Yes
Aaron	Female	Genetics	Yes
Henry	Male	Engineering	No
Team Earth			
Anna	Female	Engineering	Yes
Susan	Female	Engineering	Yes
Kelley	Female	Business	No
Patrick	Male	Engineering	No
David	Male	Cognitive Science	No

Table 12

Number of Survey Participants by Discipline

Discipline	Number	Percentage of Whole
Engineering/Computer Science	10	40%
Science	4	16%
Math	1	4%
Art/Design	2	8%
Business	3	12%
Other	5	20%
Total	25	

This method proposes a compromise between allowing conclusions to emerge from the data analysis, and testing initial hypotheses of the phenomenon being studied (Bogdan & Biklen, 2007). The modified induction analysis method consists of the following steps: 1) developing initial definitions and explanations of the phenomenon at the beginning of the research process; 2) comparing the definitions and explanations to the data during data collection; 3) modifying the definitions and explanations based on data analysis; 4) seeking data that does not fit with the existing formulas; and 5) redefining the phenomena and formulas. My initial constructs, influenced by the research questions, consisted of the following components:

1) Elements of the community of innovation framework (people, place, and program);
2) The scaffolds I had used to support the communities;
3) Examples of community building or team cohesion (or lack thereof); and

4) The challenges that the communities faced.

To assist with the understanding of how a community of innovation forms during rapid design events, I also developed constructs from Tuckman's (1965) four-stage model of team processes: forming, storming, norming, and performing.

As with the pilot study, an outside source transcribed the interviews soon after they were conducted. The interview transcripts were then imported into the NVivo software. I read through the transcripts multiple times before I began coding. I used NVivo to highlight sections of the data that matched to specific codes constructed from the participants' responses. During the coding process, I looked for words and phrases that related to the process, mindsets, and emotions experienced by the participants during the event. For example, a few participants mentioned gaining confidence in different areas during the event. These areas included individual skillsets, the actual project their team pursued, or continuing the project after the event ended. There were a total of 38 codes. I reviewed the codes and themes from each participant and considered how they assisted in constructing the narrative of each team.

During category formation, I grouped the initial codes for each participant. Each group of codes was analyzed and assigned an overarching category. An example of how NVivo was used in the coding and category process of the second iteration of the event is found in Figure 9. Some examples of the categories created included "interaction between groups," "overcoming challenges," and "team process." I then used constant comparison techniques to discover patterns and overlaps from each participant to refine the categories and develop subcategories. For example, there were enough codes relating to how the physical space was used during the event, therefore these codes were taken from the category "scaffolds supporting community," and placed in a new category, "space supporting community."

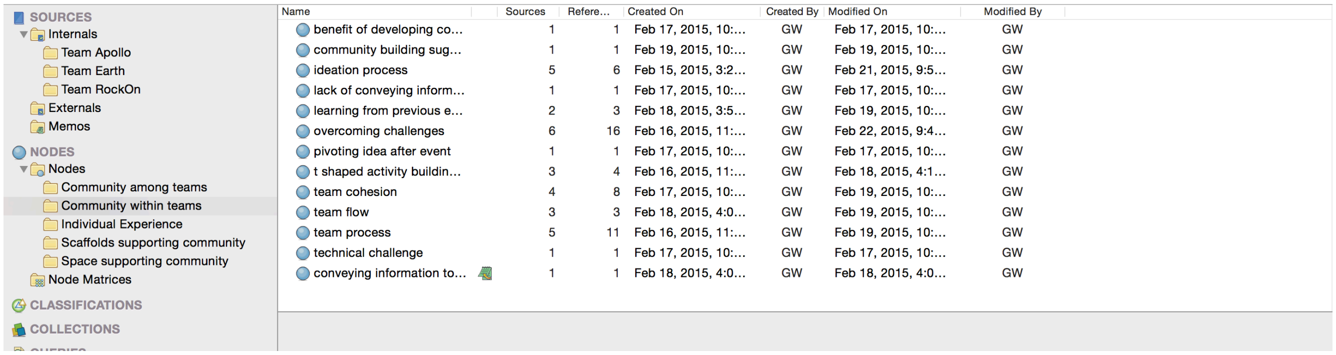


Figure 9. Categories and codes derived from the second iteration interview using NVivo.

The resulting categories from the constant comparison method consisted of “community among teams,” “community within teams,” “individual experience,” “scaffolds supporting community,” and “space supporting community.” These categories were chosen to connect with the design principles informing the study such as “promote diversity, community, and team cohesion,” “encourage the use of creative spaces,” and “maximize the success rate for participants new to rapid design activities.” The categories also helped frame the experiences of the teams used in the case studies, which sought to investigate the questions related to how communities of innovation are formed during the event. When presenting the cases, I included the examples and narratives that best communicate the communities of innovation developed in each team and in the event itself.

Establishing trustworthiness of results. Lincoln and Guba (1985) state that research credibility is achieved through prolonged engagement, persistent observation, and triangulation. Because I designed the entire series of events in this study, I was able to engage with this study for the duration of the event (11 hours). The self-containment of the event (i.e., no lectures or structured activities) allowed me to observe the entire event while making notes about what did and did not work. I achieved data triangulation by collecting data from both interviews and surveys.

To ensure the reliability of the findings, I shared them with two other researchers who provided feedback and suggestions. Throughout the educational design research process, I remained aware of the biases I had developed due to my background, and my role as both a researcher and the designer of the event. I also remained aware of how my biases could affect and influence the results and entire process (Merriam, 1998). My statement of research biases can be found in the Appendix E.

In educational design research, scalability, adaptability, and the process of integrating the results in another setting are important. To increase the opportunity for transferability of the design for this event, I have provided a detailed description of the research setting (including context and participants), design and implementation processes, research process decisions, data collection and analyses, results, findings of the team cases studied, and the design principles. This way, other researchers and practitioners can apply the intervention and theories to other informal rapid design activity environments.

Summary

This chapter reports on the methodology used to investigate the development of a rapid design practice field based on the community of innovation framework. Educational design research was used over a two-year period to carry out two iterative cycles of analysis and exploration, design and construction, and evaluation and reflection. This chapter discussed the results of the pilot study and how they informed the second iteration of the environment. The study for the second iteration of this research used interviews and surveys to develop design principles for developing rapid design practice fields and investigate how a community of innovation forms and develops during a rapid design event, how the design and entrepreneurship scaffolds support the community, and the challenges the community encounters during the event.

CHAPTER 4
FINDINGS

This chapter consists of three sections. The first section presents the experience of three teams from the second iteration of the research study, specifically how they formed a community during the event within their team and with other teams, how the design and entrepreneurship scaffolds helped guide the team, and how the team overcame any challenges. The second section analyzes the commonalities and differences among the teams. The third section presents the results of the survey data. These data are analyzed in relation to the design principles guiding the study.

Team Case Analyses

This section presents the case studies findings from the second iteration of the research study. Each team represents a case study and is presented separately. All names used to describe participants and teams are pseudonyms.

Case Study: Team Apollo

Team Apollo consisted of John (design), Ethan (engineering), Amber (consumer foods), and Alan (business). John is a graduate student, and Ethan, Amber, and Alan are undergraduate students. John and Ethan are roommates and were on the same team in the two previous events placing second each time. The second place finishes motivated Ethan to attend again, and John and Ethan began brainstorming prior to the event. The other team members had not worked together prior to this event. Amber had not attended this type of event before, but was attracted by the topic being related to food, which is her area of study. No members of the team used the Facebook page to connect with event participants beforehand. John and Amber used the page to read about example products to get an idea of the type of solutions expected. Ethan did not interact with the page at all, but relied on John to convey any important information. The T-shaped activity fostered the initial dialogue among the team and helped them figure out how each member could contribute to the team. During the activity they began sharing possible ideas. Initially, Amber attempted to find insights through her course work and by researching food trends. When no idea came from this process, Ethan facilitated an activity where each team member spoke about their average school day with respect to when he or she wanted food and where he or she obtained food. The team eventually decided to create a smoothie vending machine that was placed in the student center on campus. While conducting research on the topic, the team discovered that there would be issues with cost due to the expenses related with building the machine thus making profitability difficult. Despite these challenges, the team still pursued their idea because of the time restrictions of the event. The team conducted customer research through a survey of 30-40 students based on interest level for the vending machine, and possible ingredients and cost. For Ethan and John, focusing on customer research was a big difference from prior events when they did not focus on business aspects as much.

Due to his design background, John was responsible for creating the logo and the presentation. His advertising skills helped when deciding on a name and how to sell the product. Amber assisted with any food related aspects of the project, organizational items, and the presentation. Ethan was in charge of building a prototype to present. The team played the card game but John and Ethan suggested not getting too carried away with it like their team did at the previous event. John mentioned that “we weren’t really doing cards to get points, we were doing them to help move through our idea." Alan was primarily in charge of the card game due to his business expertise. The team took advantage of the different locations made available during the event. The creative space in the library was beneficial for Amber because she is a "visual learner" and seeing ideas written on the walls rather than just listening to them helped her. John liked having writable surfaces everywhere so that the team could see all of the ideas and designs without running out of space and having to use paper. The team missed their scheduled time in the makerspace, because they were so focused on the project. Amber and John enjoyed the opportunity to move to different spaces throughout the day, which helped reinvigorate them. However, Ethan felt that it disrupted workflow.

When the team shared the idea with mentors, the mentors shared concerned over the profitability of the vending machines. They offered suggestions such as changing the customer to the athletic facilities since student athletes are considered more health-conscious. The entire team attended the pitching class, which they think made a difference in their presentation. The team learned to not use much jargon or get too deep into the specifications of the product. The class personally affected members of the team. Amber mentioned that "what he [the pitching instructor] told me I wrote down in my notes, I will use that for the rest of my life." Ethan felt that the class should be a required class for all students. He states:

> It was something that was completely missing from my curriculum. I knew that it was missing; I just didn't know what it was missing. There was a disconnect between having an idea and having a product or being able to explain to someone that is in computer engineering, what you're doing. That's something that is lacking in the engineering department. Sometimes we forget that not everyone is an engineer.

The team had minimal contact with other teams at the event. Amber chatted with other participants during meals and participated in a video for another product. Ethan reasoned, “I think it’s really hard to stop or slow down and actually take the time to talk to anyone else.”

The team received second place for their idea. They are currently discussing working together to develop a new idea. Amber states, “I want to work with my team but I feel like we should come up with a different product. We could come up with like an easy phone app like the other group [the first place team] did, it doesn’t cost any money.” Every team member that was interviewed felt that the team worked very well together. The participants that were interviewed did not report any conflicts among the team. John and Ethan especially thought that this team was the best team they had worked on during the three events. Because of the diversity in skillsets, they believe the team was well rounded with fewer gaps in their knowledge, and more opportunities for everyone to contribute.

Case Study: Team Rock On

Team Rock On consisted of Donna (engineering), Mandy (journalism), Aaron (genetics), and Henry (engineering). Donna and Henry are graduate students and are married to each other. English is Henry’s second language, so he often looks to Donna for help him communicate with team. They also attended the previous event, but were on different teams. Mandy and Aaron are freshman students and roommates. They had never participated in this type of event, but were familiar with the design process based on activities they engaged in during high school. Mandy was intrigued about the food topic. She often discussed issues with the university dining halls with Aaron.

Prior to the event, Donna used the Facebook for reading articles to gain inspiration for possible ideas. Donna and Henry discussed ideas before the event that were shared with the other team members. The T-shaped activity helped the team know who could perform specific skills. Donna shared that the activity was helpful because "at that point I knew that one of my group mates was good at making videos and so I knew 'Okay, definitely, we should make a video at some point'…and so that was good."

During the ideation process, the team discussed their interests and issues they observed during their daily lives. They originally considered general health ideas but found it was too broad and contained too many aspects. The team then decided to address a specific problem rather than creating a universal health application. They defined their problem as "how might we simplify the process of entering the dining hall while reducing germ experience?" They eventually decided to create an application that allowed students to enter dining halls, fitness centers, and other locations on campus using their cellphone instead of the traditional "germ-harboring" hand scanners. Aaron was not originally set on the idea because she wanted to create a fitness app, but the team decided to incorporate some of her health ideas in the application. One example of a health concept included in the application is nutrition information for dining halls.

Henry worked on creating a mock up of the application and Mandy worked on the building the website and the visual graphics of the presentation. Aaron used her expertise in genetics to provide knowledge on the health aspects of the application and also contributed to the business aspect. Due to her experience at the previous event, Donna helped the team focus on customer development. She discussed what she previously learned that she wanted to use as strategy in the next event:

> I remember the judges the last time they came, they gave us some tips and points which maybe all of the groups last time didn't really pay attention to them. It was really talking to the users and kind of getting their point of view. So, I think this time….that was

something that I also wanted to really do this time because last time we didn't really do that…talk to the users that much but this time we had a chance to go out and actually talk to a lot of people, ask their opinions.

The biggest obstacle for the team was time. They wanted to talk to a lot of people about their project, but most of the dining halls were closed on the weekend. Tasks were implicitly divided among the team based on experience and level of expertise. Many of the participants interviewed from the team expressed that there was no leader in the group, but this lack of hierarchy did not keep the team from working well together. The only team cohesion issue mentioned was a possible language barrier with Henry. Mandy mentioned:

> I don't think [Henry] may have been as familiar with English, not that he didn't speak English but…I think he wasn't as comfortable talking in the group. So, I think [Donna] did a little of the in between, I think, between the two of us….[Aaron] and I and him. I think she was kind of the connection between all of the members and also she had experience with doing this kind of thing before.

For the card game, the team made a plan for the cards they wanted to complete at each level and worked on them as they completed the project. They placed more importance on the higher valued cards, and decided who completed a card task based on a team member's skills. Mandy mentioned completing the "build a website" card and "keep a design journal card" since she had already started one. The team enjoyed using the multiple locations during the event. Mandy expressed that it was easy to lose track of time in each location so it was beneficial to have the ability to change locations. She also liked working in the library creative space because the team was able to break off into two pairs to work on different elements of the project, but still be close to the rest of the team. Aaron mentioned that being in the space made her feel like she was in a movie. The team did not go to the makerspace since they were working on a digital application. Donna attended the web and mobile development popup class, which assisted her and the team in deciding how to design the application. The other team members did not attend popup classes due to losing track of time. The team met with mentors however Mandy did not think the feedback was effective. She stated:

> It's hard to like propose your idea and get feedback that was valuable in that time and I think we were too far in at both of those times to necessarily take all of their advice and truly redraft the way you could if it was a real long-term project.

The team connected with other teams during the event. Mandy had causal discussions with members from other teams and recruited participants to appear in the team's pitch video. Donna also talked to other teams and even interacted with a demo.

The team received first place for their idea, which gave some of the team members the confidence to continue with the project. Donna discussed how she initially was not planning on continuing with the project but changed her mind after winning. Despite being designated the team with the best idea, Mandy is not sure she will continue to work on the project due to her study workload. She is also not sure if the dining hall application is the right idea to continue to build. She has questions regarding the desirability, value, and investment potential of the project.

Case Study: Team Earth

Team Earth consisted of Anna (engineering), Susan (engineering), Kelley (business), Patrick (engineering) and David (cognitive science). Susan is a graduate student, and Anna, Kelley, Patrick, and David are undergraduate students. During interviews, a few of the team members mentioned not realizing the intensity of the event. Anna admitted that she did not do any research beforehand, and none of the team interacted with the Facebook prior to the event.

The team had trouble coming up with ideas initially but decided on Susan's idea of creating a water filter for kayaks. Anna discussed how Susan became the leader of the team:

> [Susan] was the one that kind of like facilitated the idea and helped us see that her idea was like the best of anything that we could think of. And she kind of took charge since she knew what she was talking about.

Susan mentioned that the team developed the idea through a traditional form of brainstorming with the teams writing down ideas on paper and picking the idea that was most innovative and appealing.

One of the team's initial biggest challenges was figuring out technical aspects of creating a filter for a kayak. None of the team had any engineering background in water dynamics or kayaking. They were tasked with designing an attachment filter system, but did not know how it would affect the kayak function. Susan discussed how the team used Google search to try to research possible designs but the concept had never been made into a public prototype. Anna mentioned how the team members struggled to find roles, although Kelley was able to use her expertise to develop a business model. Anna primarily engaged in the card game. Susan also helped with the card game and the business plan.

Team Earth had to deal with team cohesion issues throughout the event. Anna mentioned how one of the team members did not come back for the second day. She described the team member as disengaged while he was there, and "asleep most of the time." This caused issues because he created the team's Facebook page and did not give the other members the administration information for accessing the page. Susan discussed the team member as not having interest at any point in the project despite the team's desire to include him in their activities. After many unsuccessful attempts, Susan stated the team took the mindset of "okay, I guess he doesn't want to work us, that's okay, we'll just have to continue to work on this project." Anna mentioned how losing a team member in the middle of a project was a learning experience:

> In school….like before college, like you had to work together or else your participation grade would drop…this was more like a real kind of team, and made me see that some people really are just going to leave and it doesn't matter, you can't grade them if they leave.

Susan described the team's mindset after losing the team member as moving forward and increasing their individual responsibilities. Other team members also had to leave at various parts of the day. Kelley left for four hours on the first day to work, and Patrick was at church for a couple of hours on the second day. To overcome this challenge, the team increased communication and every team member was kept up to date with progress. Before leaving for work, Kelley shared her bullet points of the business aspect of the project, and her business model canvas. Overall, all the remaining team members got along well.

The team was one of few to use the makerspace. Susan described getting to the makerspace as stressful because the team did not have access to a car so they had to walk. This method of transportation took time away from the team's ability to work on their project. The team created a model of the kayak and the filter to use as a prototype. The prototype helped the team have a better understanding for the design of the filter and how they could improve on the design. While in the makerspace, the team received assistance with finding a 3D image of a kayak to print, and were able to receive advice from mentors including possible questions the judges may ask. Anna believed that the mentors were more cheerleaders than mentors because they did not really understand the concept of a kayak with a water filter. However, they were able to provide advice regarding the business model. Susan thought the advice from the mentors was helpful and helped the team frame the issue their product was trying to solve better, and improve their marketing strategies.

Because Anna knew other participants at the event, it was easy for her to interact with other teams. Susan also interacted with participants from other teams about their project and background. Susan mentioned that some other teams were more hesitant to share what they were working on to protect their idea. Susan is the only member of the team interested in pursuing the kayak water filtration system. She is currently looking for sustainability grants that can help fund further product development. She is also looking for new people to join her project.

Cross-Case Comparisons

How can communities of innovation form during rapid situated design activities?

How can just-in-time learning tools facilitate innovation scaffolding in these communities?

Participants from each team reported similar experiences for how their teams came together, decided on their idea, and developed a product or service related to the food and health challenge. Each team formed an individual community of innovation during the rapid design event. Team Rock On and Team Apollo had members who had participated in prior events and members who knew each other or worked together in other settings. This allowed those teams to develop their community faster as there were fewer introduction barriers, and the teams knew what to expect from the event. Team Earth did not have members familiar with the event and no one in the group was familiar with each other so it took them longer to form a community. None of the teams used the Facebook to connect with other participants during the event, so community was not formed until the beginning of the event. This also distracted from community being formed among all the participants. Three phases of the community of innovation development emerged as a common across all the teams during the event. A visualization of the phases can be found in Figure 10.

The first phase is community formation. During this phase, the organizers present the challenge and the participants find their teams. Communities of innovation formed during the event differ from other communities (especially communities of practice) in that the participants were randomly brought together for innovation creation rather than forming based on similar interests or project goals. The team members then have to figure out how their individual interests and skills can be combined with the challenge to create a new project. The primary method teams used to begin to create cohesion was the T-shaped activity. After initial ideation, the teams decide on a workspace that acts as a headquarters for team meetings and activity. This workspace changes as the teams move between locations.

The next phase is project development. During this phase, the teams decide on an idea and begin to use scaffolds such as the card game, mentors, and popup classes to develop their idea and receive feedback. Several interviewees described the card games as providing the steps necessary to transition from idea to product or service. One interviewee mentioned "we couldn't get started on the card game until we'd definitely solidified our idea with like a name and everything." Each team developed a strategy for playing the card game.

The most common strategy of the card game was to allocate the tasks among the team members based on expertise, focusing on cards with high points first. In some teams, only one person handled the cards if he or she had business expertise. The mentors and the instructors of the popup classes become members of the community by taking an interest in the projects and providing advice and feedback to the teams.

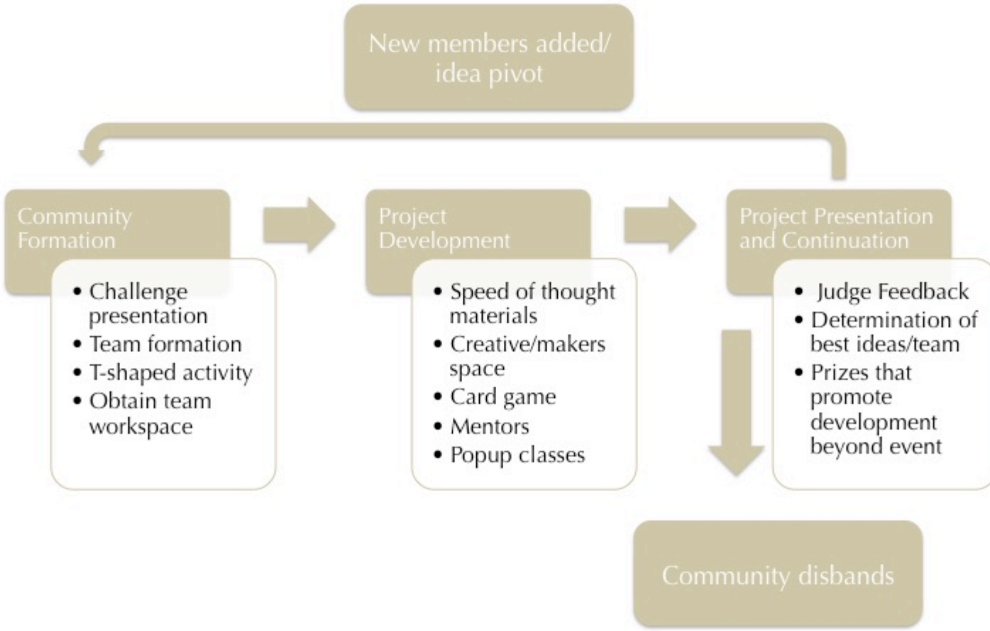


Figure 10. Phases of a community of innovation during a rapid design event

The outside members of the community were responsible for providing authentic feedback and helping develop a business mindset in the teams. All the interviewees expressed having positive experiences with meeting with the mentors and attending the classes.

The final phase is the project presentation and continuation. In this phase, teams present their projects and receive feedback from the judges. In many cases, the judges had served as mentors or instructors previously, which further ingrained them in each team's community of innovation and the overall community. The best teams, as determined by the judges, received prizes (e.g., funding, mentorship) that help promote project development beyond the event. Most teams disband their communities because participants are not interested in working on the project. Students who want to continue to work on the project may recruit new team members and form a new community of innovation. When students attend future events or work on new project teams, they are able to take lessons learned and strategies to their new communities.

There was less evidence that communities were formed among all the participants in the event. The interaction among the teams was very minimal. There are many reasons a community was not formed among the participants. There was no interaction among the participants prior to the event. The teams viewed the event as a competition so they were not comfortable sharing ideas. The lack of time also caused teams to focus solely on their projects and not devote any time to interacting with other teams. Possible solutions that will be expanded on in the next chapter are to scaffold communication among participants prior to the event, and structure activities throughout the event that fosters interaction between the teams (e.g., yoga, dance break, games). The data did show that social media could be used to provide inspiration and community information prior to the event.

How can participants in these communities overcome challenges?

The most common challenges mentioned by the participants were time constrains, technical challenges, and maintaining confidence in idea throughout the process. None of the participants interviewed reported feeling anxious, despair, or frustration over any challenges that emerged. The challenges teams did encounter were generally overcome through a variety of methods but they all involved interactions in the community within the team or the community of the entire event. The teams reported relying on each other to get through challenges, or receiving advice from the mentors, instructors, or other team members.

As mentioned previously, many researchers have reported on the increased amount of conflict that occurs in interdisciplinary teams. However, the teams that agreed to be interviewed generally enjoyed working together and did not have cohesion issues. This feedback is aligned with the research that found students who participate in informal design activities generally have a positive experience. All the participants want to be a part of the team and attempt to reach a common goal. Team Earth was the only team interviewed that lost a team member. The lost of the member did not seem to affect the team and they were able to quickly recover and continue towards completion of the project. During the event there was one team, who did not respond to interview requests, which disbanded due to one team member dropping out and another member leaving due to a family emergency. The remaining three members did not try to pursue the project, start a new idea, or join a different team. The organizations were not aware of the lost of the team until close to the end of the event, as the team did not announce their disbandment. More organizer support is needed to help teams who are having deep cohesion issues.

Design Principles and Strategies

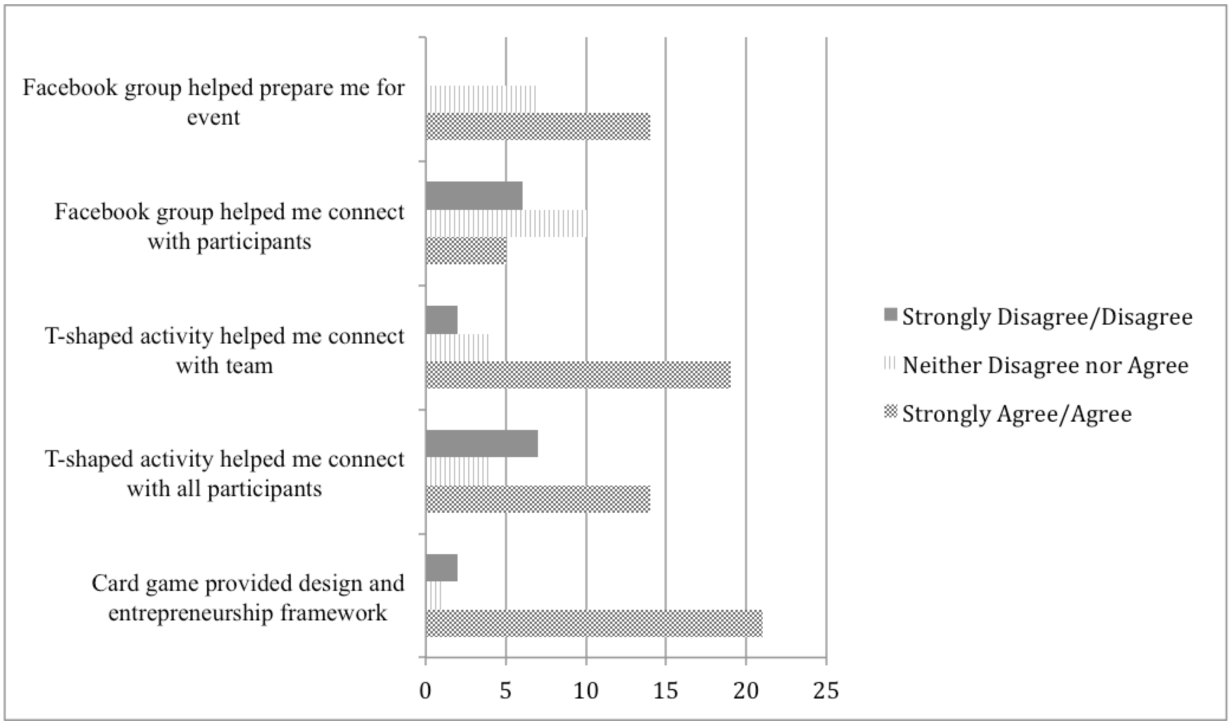
The primary goals of the second iteration of the research were to foster a community of innovation among participants and to increase authentic design activity by introducing new scaffolds and resources. The principles guiding this implementation included: 1) promoting diversity, community, and team cohesion; 2) encouraging the use of creative spaces; 3) providing multiple opportunities for teams to receive feedback on ideas; 4) maximizing the success rate for participants new to rapid design activities; 5) providing opportunities for participants to solve open and ill-defined problems; and 6) providing resources that facilitate the continuation of projects after the event. I fostered these principles by using strategies I had used in the pilot study, and new strategies, such as: 1) providing a Facebook event page that participants could use to share ideas before the event; 2) creating a T-shaped activity to help participants learn about their team’s skills and interests and those of other of event participants; 3) awarding card game points for helping other teams; 4) providing a makerspace for participant use; 5) allowing teams the choose from among multiple work spaces; and 6) encouraging participants to focus more on customer development. The findings show that these strategies had mixed results in terms of my primary goals of fostering community and creating an authentic experience. A summary of the survey results from the Likert questions can be found in Table 13.

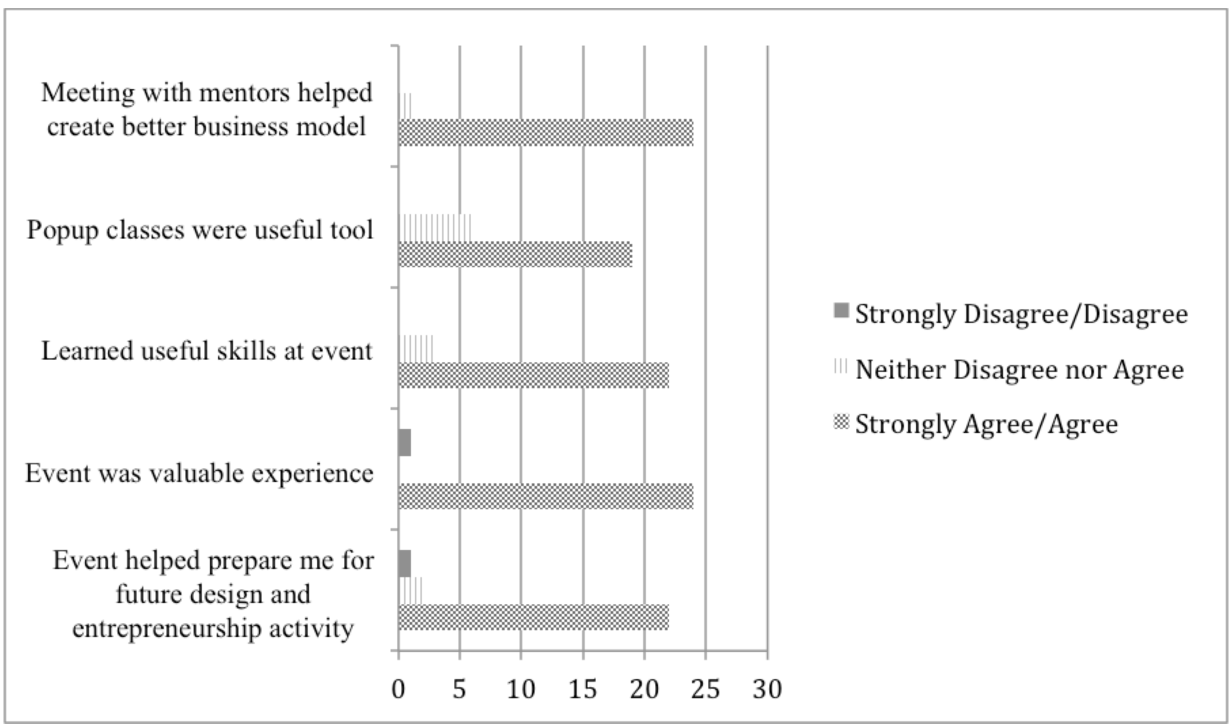
Promote diversity, community, and team cohesion. The Facebook event was not very successful in developing community before the event. Only 56% agreed that the Facebook page had prepared them for the event (4 people did not join), and only 20% agreed that the Facebook page had helped them connect with other participants. None of the participants posted to the page, but some participants "liked" the articles posted by the organizers. Many of the interviewees said they had not contributed either because no one else was contributing or because they did not feel comfortable sharing ideas. Participants primarily used the Facebook page to draw inspiration from articles posted by the organizers, or for information regarding the event. One interviewee mentioned that the reason she hadn't contributed was because it was a Facebook event page and not a Facebook group. She does not usually post to Facebook event pages.

Similar to the pilot study, teams were diverse and featured students from multiple disciplines. The T-shaped activity successfully helped teams learn about their teammates' skills and interests. A total of 76% of respondents agreed that the T-shaped activity helped them get to know the skills and interest of their team. The activity served as an icebreaker for the participants that did not know each other. The activity was not as successful at familiarizing participants with the skills and interests of participants on other teams. Only 56% agreed that the T-shaped activity helped them get to know the skills and interests of all the participants in the event.

Table 13.

Survey results from Likert questions





Many interviewees reported that they did not look at the visual T again after its initial formation. Most participants were too busy focusing on their projects to refer back to their T. The card game was not successful at getting teams to interact with one another. One team recruited participants from the two other teams to appear in their team's pitch video. No other skill swapping was reported. Teams interacted very little with one another, and the interaction that occurred was through general conversation. The competition aspect and the short time frame of the event may have hindered the interaction among the teams. More information about interaction among the teams can be found in the case studies.

Encourage the use of creative spaces. Interviewees again lauded the use of the creative space in the library for the teams to develop their projects and especially appreciated the ability to write on the walls. They considered the student learning center to be more isolated, and therefore more distracting than the library. Many of the interviewees enjoyed moving between the spaces because doing so helped them remain aware of the time and stay focused. The makerspace was only a good resource for a few of the teams. Many teams opted not to go to the makerspace because of the time it would take to travel there, which would take time away from working on the project. Other teams did not go to the makerspace because they were working on mobile applications and did not feel that it would be useful. However, the teams that did use the makerspace said it was a valuable experience.

Provide multiple opportunities for teams to receive feedback on ideas. Mentors connected with teams through Google Hangouts, and industry professionals and entrepreneurs from the local startup community taught the popup classes, mentored the teams, and served as judges to offer final feedback and determine the project with the most potential. Integrating these professionals into the event community proved very useful. A total of 96% of the participants agreed that meeting with mentors helped their team create a better business model. A total of 72% agreed that meeting with mentors gave their team confidence in its idea. A total of 92% agreed that 15 minutes was a sufficient amount of time and that they were able to learn about the mindset of a designer or entrepreneur by working with the mentors.

Maximize the success rate for participants new to rapid design activities. The card game and popup classes once again served as an effective scaffold for the teams to learn design and entrepreneurship concepts. A total of 84% of the participants agreed that the card game provided a framework for design and entrepreneurship, and 76% said that the popup classes helped them learn about design and entrepreneurship, and that 45 minutes to one hour was sufficient time for the classes.

Provide opportunities for participants to solve open and ill-defined problems. As in the previous event, I presented participants with the topic of the challenge – in this case, food, dining, health, and sustainability. I posted examples on the Facebook event page and showed the examples again during the introduction. Teams once again pursued solutions to a variety of problems. The winning team designed a mobile application for checking into public locations in the university including the dining hall and health center. The second-place team designed a fruit smoothie machine for the student center. Other projects included a reusable dining to-go box, a water filter system for kayaks, and an Oculus Rift health education application.

The event successfully trained students to develop solutions to open and ill-defined problems. A total of 96% of the participants agreed that participating in the event was a valuable experience, and 88% said participating in the event prepared them for future design and entrepreneurship activity.

Provide resources to facilitate the continuation of projects after the event. The event again encouraged many students to pursue ideas outside of the event. A total of 52% of the participants planned to continue working on their project either as a team or individually. Three people cited lack of time and a need to focus on classes as barriers to continuing their projects. Other participants were not interested in pursuing the idea. However, some interviewees and 88% of the survey participants expressed a desire to attend future thinc-a-thon events, and seek out other events in the community.

Summary

This chapter presents the findings from the second iteration of the research study. It reports on the experiences of three teams from the event, including their formation of a community of innovation with supporting design and entrepreneurship scaffolds, and any challenges encountered. The chapter also analyzes the commonalities and differences among the teams. Lastly, the chapter presents the results of the survey data used to guide the revision of design principles guiding the study.

CHAPTER 5

RESEARCH DISCUSSION

This chapter discusses the implications of the findings from the second iteration of the research study and the overall educational design research approach. A final set of design principles are presented for developing rapid design practice fields. The chapter also discusses limitations of the study and opportunities for future research and practice.

Employers seek graduates who are T-shaped, containing both a depth of knowledge in a discipline, and the ability to innovate and collaborate across disciplines (Hansen, 2010, Donofrio, Spohrer, & Zadeh, 2009). To help students develop into T-shaped professionals, educators need to create opportunities for them to participate in authentic design activities they can use to develop design and entrepreneurial mindsets. Barriers to providing an authentic experience in the traditional classroom setting present an opportunity for an informal solution. Students spend over 92% of their time outside of the formal classroom making informal learning activities essential to student development (Bell, 2009). This educational design research study was an effort to assist in student T-shaped development by creating an informal rapid design event that would allow students from diverse backgrounds to design new products and services for a given challenge. By creating a two-day experience for students to engage in interdisciplinary collaboration, design thinking, and entrepreneurship, I sought to overcome the barriers that often keep students from participating in extra-curricular activities (Lee & Wilson, 2005).

This two-year design research effort was initiated by the development of a design challenge event called thinc-a-thon, which was guided by situated learning concepts. Situated learning fosters students acquiring knowledge in the context in which it will be used (Brown, Collins, & Duguid, 1989). In situated learning environments, activities facilitate social interactions and human activity to solve real-problems. Authentic learning contexts contain problem finding, defining, and solving opportunities through collaborative activities (Young, 1993). Learning environments that facilitate authentic experiences are called practice fields. In practice fields, students have the opportunity to imitate the tasks of professionals while also exploring their goals and interests, and increasing their engagement in their studies (Jiusto & DiBiasio, 2006, Cheville & Bunting, 2011). The thinc-a-thon event served as a practice field in which students could gain experience participating in the rapid, adaptive, interdisciplinary settings they will encounter in the workplace. The thinc-a-thon event used elements commonly found in practice fields by integrating a form of problem-based learning and anchored instruction called challenge-based learning (Barab & Duffy, 2012). Challenge-based learning encourages students to focus on a big idea (or challenge), find an essential question or problem related to the big idea, and then use activities and resources to develop a testable solution for the question or problem (Johnson, Smith, Smythe, & Varon, 2009). This event also used a cognitive apprenticeship model by providing judges, mentors, and instructors to help participants develop the cognitive activity needed to engage in design thinking and entrepreneurship (Collins, Brown, & Newman, 1989). The thinc-a-thon event expanded on the concept of practice fields by allowing students to not just practice designing solutions to ill-structured problems, but actually contribute to a field by creating new products and services.

This research was guided by the elements shown in the logic map, displayed in Figure 11. The logic map conveys that the event provides the students with scaffolds that allow them to participate in activities that emulate real design practices; these scaffolds include industry mentors, prototyping tools, a design and entrepreneurship card game, and flexible creative spaces. The pilot study, consisting of 30 students, used surveys and interviews to show that the participants found these scaffolds engaging and instructive for learning design and entrepreneurship concepts.

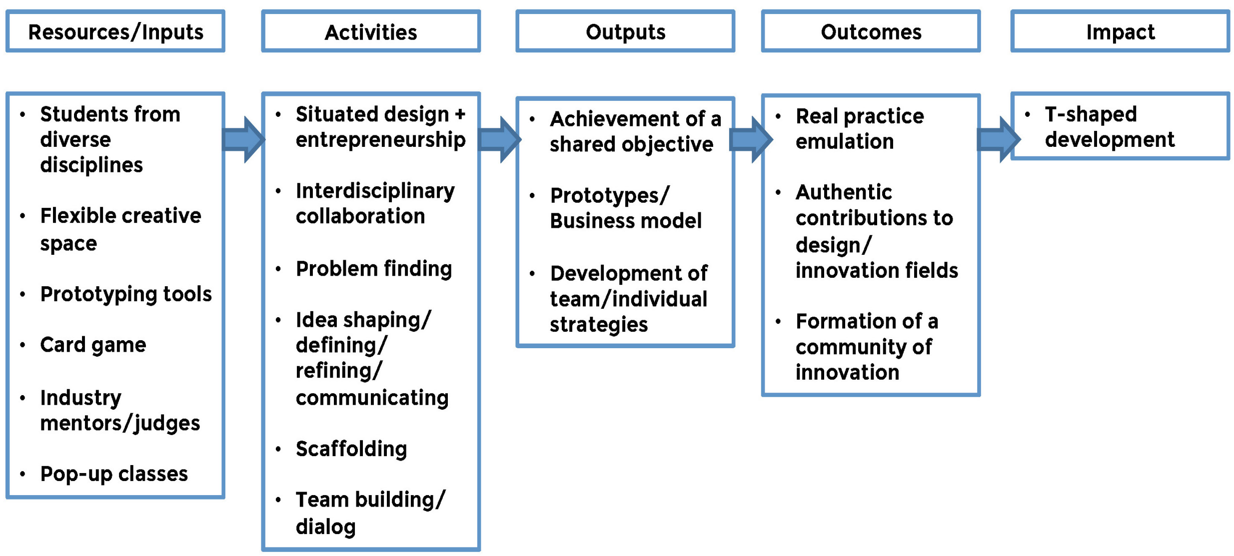


Figure 11. Logic map for thinc-a-thon event

Community development is essential for the success of design and entrepreneurship activities (Hindle, 2010). Students who participated in the thinc-a-thon event formed a community of innovation in which innovation development was the primary goal. Communities of innovation have attributes such as collaborative brainstorming, idea prototyping, reflection, and development of group flow (West et al., 2011). I developed a community of innovation framework that expands on the concept by structuring it into people, place, and program elements. Based on results from the design studies, I have added features to the community of innovation framework – Figure 12 shows the updated model.

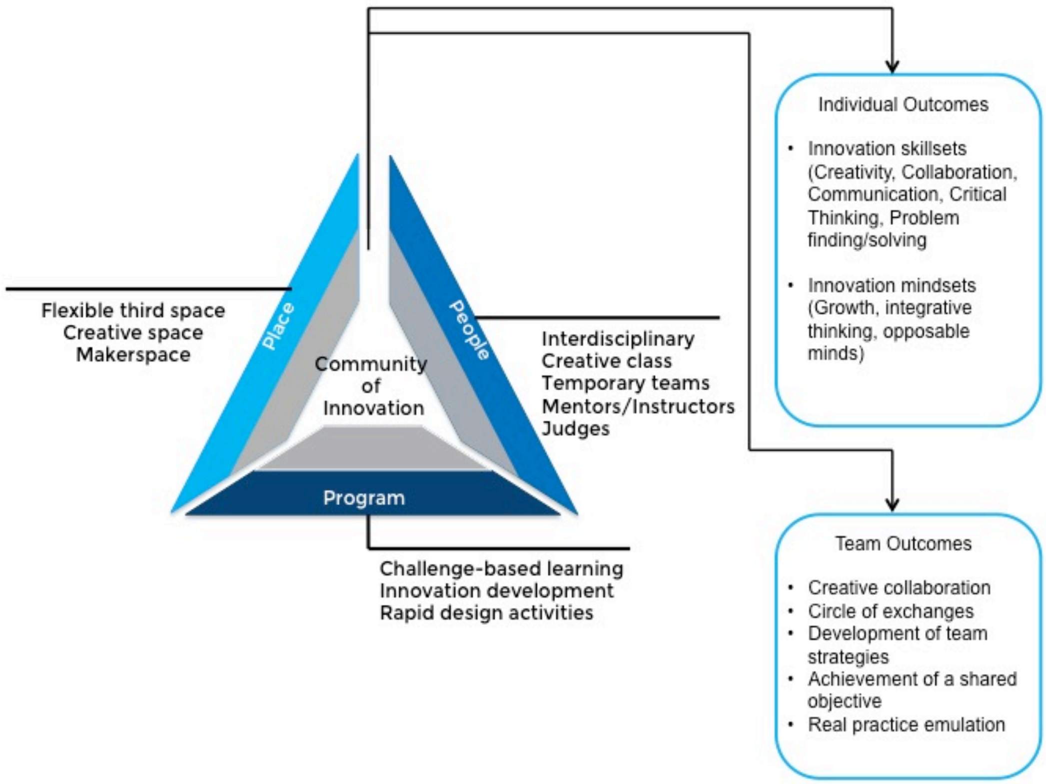


Figure 12. Revised conceptual framework for developing design practice fields

Feedback from the participants in the second design event suggests that not only the interdisciplinary teams, but also the mentors, instructors, and judges became a part of the community – the people part of the framework. These new community members often serve multiple roles and become invested in the teams' projects. The study also confirmed that creative spaces such as the library and the makerspace are important place elements for forming a successful community of innovation. It is important to provide participants with flexible, open spaces that foster building, testing, and failing in an iterative manner.

Educational design research generally produces three outputs: principles that act as knowledge in the field, new curriculum that contributes to local practice and environments in broader settings, and participant professional development (McKenney et al., 2006). This design study produced an expanded community of innovation framework, seven design principles, and 21 development strategies to guide the practice and research of informal rapid design practice fields. These principles offer strategies for ensuring the people, place, and program elements of the rapid design practice fields produce an authentic innovation setting. Table 14 presents the suggested chronological order of the primary activities for the event. Table 15 presents the design principles and strategies that I modified based on the findings of the second iteration and, if applicable, their connection to the primary activities from the previous table.

One change to the design principles is a distinction between promoting diversity, community, and cohesion within the teams and encouraging community among all the event participants. In this iteration, the T-shaped activity did not facilitate community among members of different teams, but the activity could serve this goal if organizers explained to the participants that they should use the T idea to find people on other teams with skills that could complement the skills on their own team. Promoting a team sharing culture would have to involve emphasizing building community despite the competition aspect of the event. One interviewee suggested creating a Web site where students could share interests and skills before the event, and then making this site accessible to teams during the event. The Facebook event page may also be more effective if it is heavily scaffolded for students who are not used to engaging with others in online forums. One interviewee recommended creating a Facebook group instead of a Facebook event page because people normally only use event pages to learn information about the event.

Table 14.

Chronological order of primary event activities

Identifier	Time	Description
A	Prior to and during the event	Facebook group
B	Morning	Introduction of challenge and card game
C	Morning	T-shaped activity
D	Afternoon-Evening/Day 2	Product building in creative/makerspace
E	Afternoon-Evening	Popup classes
F	Afternoon-Evening/Day 2	Mentor sessions
G	Evening/Day 2	Community building activities
H	Day 2	Project presentations

Table 15.

Finalized design principles and strategies. (Associated activity identifiers can be found in Table 14)

Principles	Strategies	Associated Activity
People		
Promote diversity, community, and cohesion within the teams	• Create interdisciplinary teams with a diverse set of skills and experience • Facilitate the T-shaped activity to encourage discussion	C
Encourage community among all event participants	• Encourage participants to use the T activity to connect with others	C
	• Create a Facebook group for sharing ideas and discussion before the event (may need to be heavily scaffolded initially)	A
	• Award card game points for helping other teams	B
	• Facilitate whole-group activities throughout the event	G

Table 15.

Finalized design principles and strategies (continued.)

Principles	Strategies	Associated Activity
	Place	
Encourage the use of creative spaces	• Host event in a collaborative space. If space is normally used for studying, close space to alternative uses • If possible, use space in startup community • Provide a makerspace for developing physical products • Allow teams the choice of multiple work spaces in within walking distance from one another	D D D
	Program	
Provide multiple opportunities for teams to receive feedback on ideas	• 15 minute sessions with mentors in person and through Google Hangout • Encourage teams to seek feedback from one another • Teams present to and receive feedback from judges	F H
Maximize the success rate for participants new to rapid design activities	• Create a card game designed to teach students how to navigate the design and entrepreneurship process • Provide popup classes on various related topics • Encourage participants to focus more on customer development (card game + popup class) • Provide enough time to allow teams to fully develop ideas past hypothetical stage (32+ hours)	B E B/E

Table 15.

Finalized design principles and strategies (continued.)

Principles	Strategies	Associated Activity
	Program	
Provide opportunities for participants to solve open and ill-defined problems	• Teams must create a new product or service that solves a problem within the given challenge	
Supply resources to facilitate the continuation of projects after the event	• Offer funding to further develop projects with the most potential • Connect with local incubators to facilitate mentorship after the event • Provide a website for recruiting new team members and sharing new ideas	

Another method for facilitating community among event participants would be to organize activities throughout the event that encourages interaction among the teams (e.g., yoga, dance competitions, raffles).

The open creative spaces in the library and student center successfully fostered creative collaboration. However, because the spaces were open, students who were not participating in the event continued to use the spaces for studying and general use. This took away from the startup culture atmosphere because it lowered the overall activity level: organizers were reluctant to play loud music, and teams were reluctant to engage actively. This lack of activity takes away from creating a startup culture during the event. It also prevents the development of a third space, a place for conversation, collaboration, and taking risks (Shaffer, 2014). I recommend that future organizers close the event location to people who are not part of the event. Alternatively, organizers might secure a local startup community space so that the students can be in an authentic environment and work alongside entrepreneurs who are working on their own startup ideas. Also, spaces that are open for teams to use (e.g., makerspace) should be in reasonable walking distance so traveling between them doesn't take too much time away from project development.

While the event provided opportunities for teams to get project feedback from mentors, instructors, and judges, it did not provide many official opportunities for teams to share their ideas and get feedback from one another. Some interviewees said that their teams were reluctant to share their idea with others teams because they did not want their idea stolen. More organized opportunities for project sharing would show participants that sharing is a part of the startup culture and is encouraged. The event time for this event was 32 hours and included the opportunity for teams to stay overnight. Only one team took advantage of this opportunity because it was not mandatory. To allow teams the opportunity to fully develop their projects, staying overnight should be mandatory or strongly encouraged, and enough time should be allowed for teams to take advantage of all available mentors and classes. To facilitate the continuation of projects and teams after the event, organizers should provide funding and mentorship to teams with the most potential to develop their ideas, as well as a Web site dedicated to helping participants find new team members and share ideas.

As a practice outcome, this educational design research study produced an annual rapid design event that brought students from various disciplines together to create new products and services based on the given challenge.

The framework of this event can act as an inspiration and guide to other universities and colleges that want to foster design and entrepreneurship mindsets in their students, and encourage them to turn their ideas into reality. A few of the teams who participated in the thinc-a-thon event have further developed their ideas and received seed funding from investors.

By playing multiple roles in the events I was able to engage in professional development. I gained in-depth knowledge about informal design learning environments, situated based learning, experiential learning and educational design research. I was also able to take the concept of developing a rapid design practice field and construct an event that engaged students, faculty, and local entrepreneurs in innovation building. These learning experiences will help guide my future research and teaching practice.

Study Limitations and Implications for Future Research and Practice

I derived most of the study's data from participant self-reports. I assumed that participants gave open and accurate responses to the survey and interview questions. Because a large part of the data was qualitative, the results were more specific than generalizable. The small number of participants used in each study also decreases generalizability. A total of 30 students participated in the pilot study, and 25 students participated in the second iteration. In addition, I did not interview every student from each team for the case studies, so some vital information from the teams could be missing as a result. The interviewees were able to discuss the thoughts and behaviors of their team members to some extent, but not completely. Members of the team that had the most issues and eventually disbanded did not make themselves available for interviews, which meant that I could not use them as a case. The challenges and conflicts they encountered would be very helpful in answering the study's research questions.

It is also necessary to investigate the role of fatigue in rapid design events. These events range from 24-54 hours and many students who are not used to participating in this type of event may deal with fatigue at some point in the event. Students who deal with increased fatigue or encounter it early in the event may have a more negative experience. Investigating the role of fatigue will also help determine the appropriate number of hours of the event.

The most important next step of this project is to conduct more iterations of the event, especially without the presence of the researcher. Future iterations could explore the sustainability, transferability, and generalizability of the design research outcomes at the local level and in broader settings. To see if the design principles and strategies of this study are viable, they need to be tested in varied settings with 100 or more participants.

Future research must also confirm that the activity actually helps students develop into T-shaped professionals. This study confirmed many of the team outcomes from the community of innovation framework including creative collaboration, development of strategies, achievement of a shared objective, and real practice emulation. This study did not, however, confirm individual outcomes. An appropriate next question is, "How can rapid design activities influence the development of skillsets and mindsets that foster innovation?" Innovation skill sets involve creativity, collaboration, communication, critical thinking, and problem finding and solving. Innovation mindsets include growth, integrative thinking, and opposable minds. Researchers could determine how much influence the rapid design activity and communities of innovation have on the development of these skill sets and mindsets by administering surveys and conducting interviews, both during and after the event, and asking students for self-reported reflection. Tranquillo (2014) created a pre- and post-survey to measure perceived growth in design skills and mindset change in engineering students who participated in a 10-week design boot camp. It is also necessary to investigate whether students are able to transfer what they learn in these practice fields to other areas such as internships and class and personal projects. Appropriate methods for this type of study include observations, longitudinal interviews, and design document analysis.

The communities of innovation formed during the event encountered some of the same barriers West (2009) identified including lack of enough time for innovation building, gaps in technology knowledge and skills, and minimum collaboration with non-team member participants. More iteration cycles through the educational design research approach are needed to develop principles for overcoming these barriers. Lastly, I recommend interviewing the mentors, instructors, and judges of the event to investigate how they fit into the community of innovation formed during the event and their experiences. This additional information can help complete the story of communities of innovation developed during rapid design events.

Conclusion

This study investigated the development of rapid entrepreneurship practice fields designed to engage students in developing entrepreneurial mindsets and skills. Using the framework of people, place, and program, I formed a community of innovation that fostered repeated situated activity and emulated real practice. The thinc-a-thon event discussed in this study used elements of the framework to engage students in entrepreneurship and provided opportunities for the continuation projects after the event. I used an educational design research approach to develop an environment for the event and test its effectiveness through multiple iterations. I designed multiple studies that used a mixed-methods approach to create a set of design principles for designing an informal rapid design activity. The final set of design principles included: 1) promote diversity, community, and cohesion within the teams; 2) encourage community among all the event participants; 3) encourage the use of creative spaces; 4) provide multiple opportunities for teams to receive feedback on ideas; maximize the success rate for participants new to rapid design activities; 5) provide opportunities for participants to solve open and ill-defined problems; and 6) supply resources to facilitate the continuation of projects after the event.

The pilot study found that participation in the event taught students design and entrepreneurship concepts that they wouldn't have otherwise have learned in their studies, altered their view of their own and other disciplines, and gave them the confidence to work on new and old business ideas after the event. The second study looked more deeply into the development of communities of innovation during a rapid design event. This study found that the event led participants through three phases of a community of innovation: community formation, project development, and project presentation and continuation. While participating in the community, students encountered many problems, including time constrains, technical challenges, loss of team members, and missing expertise. To overcome these challenges, teams often looked for help from members of the larger community, including mentors, instructors, and other teams.

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Appendix A. Example flyer from thinc-a-thon event

Appendix B. List of design card game tasks from second iteration

Level 1 - 100 points

- Play the Brainspin game
- Participate in the Stinky Fish activity
- Design a logo
- Create a company website/launch site
- Interviewing for empathy
- User research surveys
- 50 ideas in post it notes
- 6-8-5 Gamestorming
- Construct a persona profile
- Sketch one of your ideas
- Start a social media campaign for your project
- Be Meta: Use a card deck to inspire ideas
- Role play your idea

Level 2 - 250 points

- Build a storyboard
- Use a design journal to track progress
- Sketch Your Ideas
- Define your problem (POV/HMW)
- Rapid prototype your idea

- 3D print a prototype
- Create a crowdfunding campaign
- Make a Innovation 2x2 chart

Level 3 - 500 points

- Interview for empathy (at least 10 people)
- Design a customer research survey (get at least 30 responses)
- Complete a Business Model Canvas
- Record reflection from testing

Level 4 - 1000 points

- Use a design journal to track progress
- Design for a solution for a social cause
- Design for your local community
- Construct your team's design process
- Swap skills with another group
- Conduct a co-creation session

Level 5 - 2000 points

- Pursue a moonshot idea
- Go Viral (Get 250 Facebook likes, Twitter followers, or YouTube views)

Appendix C. Participant Survey Instrument from pilot study

Default Block

Dear participant,

You are invited to participate in a study on the use of collaborative transdisciplinary design challenges in informal learning settings. Research participants will reflect on their experience participating in an interdisciplinary design challenge. You must be 18 years or older to participate.

The purpose of this research project is to gauge how this experience affects your entrepreneurship aspirations and influences your entrepreneurship and design thinking mindset.

There are no incentives for participating in the study. The benefits that you may expect from participation are the opportunity to reflect on your design challenge experience. No risks, discomforts or stresses are expected from participation in the study. Participation is voluntary and you are free to withdraw your participation at any time without penalty or loss of benefits to which you are otherwise entitled. If you decide to stop or withdraw from the study, the information/data collected from or about you up to the point of your withdrawal will be kept as part of the study and may continue to be analyzed.

Please note there is a limit to the confidentiality that can be guaranteed due to the technology itself. While the researcher may ensure the confidentiality of a participant by utilizing standard procedures (pseudonyms, etc.) when the researcher writes up the final research product, the researcher cannot ensure confidentiality during the actual Internet communication procedure. If you rather complete a physical version of the survey, please email mrwilson@uga.edu.

By completing the survey you are agreeing to participate in the research.

If you have any questions or concerns, feel free to contact Gregory Wilson at mrwilson@uga.edu. We hope you will enjoy this opportunity to share your experiences and viewpoints with us. Thank you very much for your help.

Name

____

Gender

- ○ Male
- ○ Female

Discipline

- ○ Engineering/Computer Science
- ○ Science
- ○ Math
- ○ Art/Design
- ○ Business
- ○ Other ________

Level

- ○ Undergraduate
- ○ Graduate

Year

- ○ 1st Year
- ○ 2nd Year
- ○ 3rd Year
- ○ 4th Year

- ◯ 5th Year +

After graduating I currently plan to......

- ◯ Get a job
- ◯ Start a business
- ◯ Go to graduate school
- ◯ Other

Was this your first time attending this type of event (i.e. design challenges, hack-a-thons, entrepreneurship competition)

- ◯ Yes
- ◯ No

How did you hear about this event?

- ◯ Flyers
- ◯ Social Media
- ◯ Word of Mouth
- ◯ Thinc Website

What was your reason for attending this event? (Check all that apply)

- ☐ Interested in topic
- ☐ Wanted to start a new business
- ☐ Wanted to practice design
- ☐ Wanted to collaborate with others
- ☐ Other

I enjoy collaborating with students from different disciplines.

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neither Agree nor Disagree
- ◯ Agree
- ◯ Strongly Agree

I wish there were more opportunities on campus to collaborate with students from different disciplines.

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neither Agree nor Disagree
- ◯ Agree
- ◯ Strongly Agree

Did this event alter your view of your own discipline or your respective team members' discipline?

◯ Yes

◯ No

How so?

[ ]

There are many opportunities to practice design thinking and entrepreneurship in my field.

◯ Strongly Disagree

◯ Disagree

◯ Neither Agree nor Disagree

◯ Agree

◯ Strongly Agree

Please answer the following questions about today's experience.

	Very Dissatisfied	Dissatisfied	Somewhat Dissatisfied	Neutral	Somewhat Satisfied	Satisfied	Very Satisfied
How satisfied were you with what happened today?	◯	◯	◯	◯	◯	◯	◯

Please answer the following questions about today's experience.

	Not Frustrated At All	Neutral	Somewhat Frustrated	Frustrated	Very Frustrated
How frustrated were you with what happened today?	◯	◯	◯	◯	◯

What was a moment you enjoyed most today?

[ ]

What was a moment you felt most inspired by today?

[ ]

This event provided the necessary tools to design and develop my team's ideas.

◯ Strongly Disagree

◯ Disagree

◯ Neither Agree nor Disagree

◯ Agree

◯ Strongly Agree

What tools would enhance the experience?

[ ]

Participating in the thinc-a-thon card game helped my team utilize design thinking activities

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

Participating in the thinc-a-thon card game helped me learn more about design thinking

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

Participating in this event allowed me to use skills learned from my classes in my discipline.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

Participating in this event helped me learn useful skills that I haven't learned in my classes.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

What skills did you begin to develop by participating in this event ?

Are you planning on continuing with the project that was created at this event?

- Yes
- No

Why not?

- Lack of funding
- Other team members not interested
- Can't find people with necessary skill
- Lack of interest
- Other

Participating in this event was a valuable experience.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

Will you attend this type of event again?

- Yes
- No

Why not?

Appendix D. Interview Protocol

- When you signed up for the event, what were you expecting?
- Any prior experience working in interdisciplinary teams?
    - What was it like?
- When you met your teammates, how did it you all quickly gain trust for each other?
- How did you come up with your idea?
- What was the team process?
- What was your role?
- What conflicts did your team encounter during the event?
- What was it like participating in the card game?
- I asked you about enjoyment, inspiration, and frustration on my survey. Now, looking back, can you describe what sorts of things you enjoyed… inspired you… frustrated you?
- What were the high and low points of the thinc-a-thon experience for you?
- How did the context – the environment, the schedule, and the organization of thinc-a-thon – help you create your project?
- How did it hinder it?
- If you could go back in time, what – if anything - would you do differently?
- What are your overall takeaways and feedback?

Appendix E. Statement of Research Biases

Akker et al. (2006) states that the first step towards overcoming potential obstacles is acknowledgement of the impact of the dual roles. In relation to the project, I am the designer and organizer of the thinc-a-thon event. Combining these roles with the researcher role can create many issues, as I am expected to be both an advocate and critic of the project(Akker et al., 2006). Putnam and Borko (2000) mentions that “rather than pretending to be objective observers, we must be careful to consider our role in influencing and shaping the phenomena we study” (p. 13). To prevent issues like evaluator effect, I will have to maintain a natural setting during the event and strive for unobtrusiveness. One method for achieving this context is involving others in the implementation of the event.

I have been involved in many design teams and rapid design activities. I cannot make the assumption that participants will react to the learning environment in the same way as I have or express similar views on design and innovation. My views tend to lean towards the constructionist approach to motivate learning by introducing personally meaningful design activities (Resnick, 2007). While the use of grounded theory can limit any biases towards the data, it is possible that viewing the data through a different theoretical lenses could offer different results.

Appendix F. Event schedule from second iteration

thinc·a·thon

Thinc. Build. Play.

Design + Food (+ Health)
January 31st – February 1st, 2015

Thinc. at UGA. The Spirit of Entrepreneurship

Official Schedule

Saturday 31st January

Miller Learning Center (4th floor Rotunda)

Registration + Breakfast
8am - 9am

Welcome + Logistics
9am - 9:30am

Team building activity
9:30am -10:30am

Dinner
7pm -9pm

After hours design
9pm-8am

Science Library (Makerspace on 2nd floor)

Prototyping popup class
1pm-2pm

Makerspace Open
(By appointment only)
2pm-7pm

Main Library (4th floor study space)

Collaborative Space Use
11am – 7pm

Lunch
12:00pm - 2pm

Web and Mobile Development popup class
1pm - 2pm

Art + Technology popup class
2:30pm - 3:30pm

Pitching popup class
4pm - 5pm

Customer Development popup class
5:30pm - 6:30pm

Sunday 1st February

Miller Learning Center (4th floor Rotunda)

Breakfast
8am - 9am

Work on projects/presentations
9am - 1pm

Lunch
12pm - 1pm

Survey
1pm - 1:30pm

Presentations
1:30pm - 3:30pm

Announcement of winners and final remarks
3:30pm - 4pm

Appendix G. Participant Survey Instrument from second iteration

Default Block

Dear participant,

You are invited to participate in a study on the use of collaborative transdisciplinary design challenges in informal learning settings. Research participants will reflect on their experience participating in an interdisciplinary design challenge. You must be 18 years or older to participate.

The purpose of this research project is to gauge how this experience affects your entrepreneurship aspirations and influences your entrepreneurship and design thinking mindset.

There are no incentives for participating in the study. The benefits that you may expect from participation are the opportunity to reflect on your design challenge experience. No risks, discomforts or stresses are expected from participation in the study. Participation is voluntary and you are free to withdraw your participation at any time without penalty or loss of benefits to which you are otherwise entitled. If you decide to stop or withdraw from the study, the information/data collected from or about you up to the point of your withdrawal will be kept as part of the study and may continue to be analyzed.

Please note there is a limit to the confidentiality that can be guaranteed due to the technology itself. While the researcher may ensure the confidentiality of a participant by utilizing standard procedures (pseudonyms, etc.) when the researcher writes up the final research product, the researcher cannot ensure confidentiality during the actual Internet communication procedure. If you rather complete a physical version of the survey, please email mrwilson@uga.edu.

By completing the survey you are agreeing to participate in the research.

If you have any questions or concerns, feel free to contact Gregory Wilson at mrwilson@uga.edu. We hope you will enjoy this opportunity to share your experiences and viewpoints with us. Thank you very much for your help.

Name

Gender

- Male
- Female

Discipline

- Engineering/Computer Science
- Science
- Math
- Art/Design
- Business
- Other

Level

- Undergraduate
- Graduate

Year

- 1st Year
- 2nd Year
- 3rd Year
- 4th Year
- 5th Year +

After graduating I currently plan to......

- Get a job
- Start a business
- Go to graduate school
- Other

Was this your first time attending this type of event (i.e. design challenges, hack-a-thons, entrepreneurship competition)

- Yes
- No

How did you hear about this event?

- Flyers
- Social Media
- Word of Mouth
- Thinc Website

What was your reason for attending this event? (Check all that apply)

- Interested in topic
- Wanted to start a new business
- Wanted to practice design
- Wanted to collaborate with others
- Other

Please answer the following questions about today's experience.

	Very Dissatisfied	Dissatisfied	Somewhat Dissatisfied	Neutral	Somewhat Satisfied	Satisfied	Very Satisfied
How satisfied were you with what happened today?	○	○	○	○	○	○	○

Please answer the following questions about today's experience.

	Not Frustrated At All	Neutral	Somewhat Frustrated	Frustrated	Very Frustrated

How frustrated were you with what happened today? ◯ ◯ ◯ ◯ ◯

What was a moment you enjoyed most today?

What was a moment you felt most inspired by today?

This event provided the necessary tools to design and develop my team's ideas.

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neither Agree nor Disagree
- ◯ Agree
- ◯ Strongly Agree

What tools would enhance the experience?

Participating in the thinc-a-thon card game provided a framework ("how-to") on how to engage in design and entrepreneurship

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neither Agree nor Disagree
- ◯ Agree
- ◯ Strongly Agree

Meeting with the mentors helped my team create a better business model/product

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neither Agree nor Disagree
- ◯ Agree
- ◯ Strongly Agree

Meeting with the mentors gave my team more confidence in our idea

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neither Agree nor Disagree

- Agree
- Strongly Agree

Meeting with the mentors for 15 minutes was enough time for my team to share our idea and receive useful feedback.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

I was able to learn about the mindset of a designer/entrepreneur by meeting with the mentors.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

The popup classes were useful for learning skills related to design and entrepreneurship

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

45 minutes to 1 hour was enough time to learn the topic from each popup class.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

Participating in this event helped me learn useful skills that I haven't learned in my classes.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

What skills did you begin to develop by participating in this event ?

Are you planning on continuing with the project that was created at this event?

- Yes
- No

Why not?

- Lack of funding
- Other team members not interested
- Can't find people with necessary skill
- Lack of interest
- Other

Participating in this event was a valuable experience.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

This event prepared me for future design or entrepreneurship activity

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

Will you attend this type of event again?

- Yes
- No

Why not?