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Distributed Apprenticeship and Social Technologies in Informal Communities of Entrepreneurs

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ABSTRACT

Distributed Apprenticeship and Social Technologies in Informal Communities of Entrepreneurs

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Greater interest in self-directed professions, like entrepreneurship, have led to a growth in informal workplace communities and social technologies that support new ways of working. However, we have little understanding of how these socio-technical environments support opportunities for professional skill development through apprenticeship. The goal of this dissertation is to understand how social technologies are facilitating opportunities for apprentice-like instruction in co-located and distributed informal entrepreneurial communities. I first take a primarily qualitative approach involving interviews and participant observations to understand how apprenticeship is instantiated in informal entrepreneurial communities, such as in makerspaces and crowdfunding, without dedicated formal guidance. I then apply these insights to develop and evaluate a novel tool, IntroAssist, that helps novice entrepreneurs perform introductory help-seeking in these communities. Theoretically, this work provides an emergent understanding of how social technologies support new forms of apprenticeship in distributed informal workplace contexts. Practically, this work identifies design implications and presents a tool that highlights how social technologies can be developed to better support opportunities for apprenticeship.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

A significant portion of US job growth is fueled by entrepreneurship (Decker, Haltiwanger, Jarmin, & Miranda, 2014)—the recognition and pursuit of novel opportunities by mobilizing and combining resources in new ways (Shane, 2003). Entrepreneurship is important to all sectors of industry because it allows people working on the cutting edge to develop and deploy products and services that drive economic productivity (Solow, 1956). The rate of entrepreneurship has rebounded over the past 10 years. For instance, about 540,000 adults are switching into self-employed business ownership each month (R. Fairlie, Morelix, & Tareque, 2017). Many of these people are choosing entrepreneurship as the most viable way to tackle the most pressing global challenges because it allows the freedom to test and pursue new impactful ventures. ***The goal of this work is to understand and design socio-technical systems that help novice entrepreneurs with limited resources build and leverage community relationships to develop entrepreneurial skills.***

Despite a growth in entrepreneurial activity, there are still wide gaps in access and performance (R. W. Fairlie, Robb, & others, 2008; Herrington & Kew, 2017). Entrepreneurship depends on diverse participation to provide the range of opinions and insights critical to addressing today's "wicked" problems, such as income inequality, affordable healthcare, and environmental sustainability (Buchanan, 1992; Page, 2008; Rittel & Webber, 1973). However, those who start out with limited access to entrepreneurial resources (i.e. financial, social, human, instructional capital) inherently face higher barriers to developing skills critical for success (R. W. Fairlie, Robb, & Hinson, 2010; Loscocco, Robinson, Hall, & Allen, 1991).

Researchers and practitioners in both entrepreneurship and learning sciences argue that authentic practice is needed to develop skills in particularly complex work, like entrepreneurship (Kauffman Foundation, 2008). Complex work is non-routine, difficult to plan, requires diverse resources, involves different types of workers and coordination, and includes various project goals (Strauss, 1988). Authentic practice is necessary for skill development in complex work because it encourages novices to develop the skills needed to process information, develop plans, and adjust strategies in face of hard-to-predict, real-world challenges (Cope, 2005; St-Jean & Audet, 2012).

However, there are few sources of entrepreneurial instruction that are both authentic and low barrier-to-entry for novice entrepreneurs, who are in the early stages of developing and deploying new products or services. For instance, being an apprentice in a startup is a highly authentic experience, but requires high social capital as the number of novices seeking this opportunity greatly outnumbers the experienced entrepreneurs able and willing to provide long-term dedicated guidance. Accelerator and incubator programs also provide novices authentic entrepreneurial experiences with structured curricula and mentorship, but can be very competitive with acceptance rates of 5-10%. Formal training through college or business school can also be very expensive and highly selective. Simply reading about entrepreneurship in a book or article is very accessible, but highly inauthentic. Of course, the creation of these instructional sources have improved entrepreneurial practice over the years, but existing gaps in performance highlight that further steps are needed in order to make these opportunities to skill development more widely available.

Informal entrepreneurial communities are lowering the barrier for novice entrepreneurs with limited resources to participate in authentic entrepreneurial activity. I define informal entrepreneurial communities as distributed and co-located communities of people who perform some or all parts of entrepreneurial work together or in parallel without formal guidance (e.g. manager, set curriculum). Research in human-computer interaction (HCI) describes how co-located entrepreneurial communities, like hackerspaces and makerspacers, are supporting novice entrepreneurs by bridging emerging creative activity to the large-scale fabrication industry (Lindtner, Hertz, & Dourish, 2014). Research in management describes how people selling their products in distributed informal entrepreneurial communities, like online marketplaces (e.g. Etsy) and crowdfunding platforms (e.g. Kickstarter), use social technologies to provide each other with social and financial support needed in early stage ventures (Kuhn & Galloway, 2015). These socio-technical systems—environments where social interactions shape and are shaped by technology (Orlikowski, 1992; Trist, 1981)—are changing how people share financial, social, human, and instructional resources.

While advances in socio-technical systems have made it easier to participate in authentic entrepreneurial practice, they have also introduced new and understudied challenges to scaling expert instruction. Apprenticeship—having novices observe and work alongside an expert to develop strategic and metacognitive skills—has been lauded as one of the most effective approaches to instruction in authentic workplace contexts (Collins, 2006). But, in-person, one-on-one guidance is not easily scalable (Collins, 2006). Unlike accelerators, incubators, and schools, where expert instructors are required or hired to provide dedicated on-demand guidance, informal entrepreneurial communities typically do not have formal structures of educational

support. This dissertation seeks to understand how apprenticeship can be enacted in informal entrepreneurial communities where there is limited dedicated formal guidance and community sizes range from over a hundred to thousands of people.

1.1 Research Questions

In order to support opportunities for apprenticeship, informal entrepreneurial communities need to provide novice entrepreneurs with lower barriers to authentic practice with accessible instructional guidance. To address my research goals, I pose the following research questions:

- **RQ1:** How do the socio-technical affordances of *co-located* informal entrepreneurial communities support apprenticeship in the absence of dedicated expert instructors?
- **RQ2:** How do the socio-technical affordances of *distributed* informal entrepreneurial communities support apprenticeship in the absence of dedicated expert instructors?
- **RQ3:** How might we leverage cognitive apprenticeship instructional methods of modeling, coaching, and reflection in an online context to support help seekers in writing introductory help requests?

1.2 Overview of Thesis

The goal of this work is to understand how informal entrepreneurial communities can be designed to support low barriers to skill development in authentic work environments. I take a design research approach (Norman, 1988; J. Zimmerman, Forlizzi, & Evenson, 2007), using both qualitative and quantitative methods, such as interviews, participatory observations, surveys, and an experiment to deeply understand experiences of novice entrepreneurs, generate theory, and

produce design interventions. This interdisciplinary work contributes to the fields of human computer interaction (HCI), entrepreneurship, and learning sciences. In order to address the research questions, I approach this work through the following studies:

Study 1: Apprenticeship in a Co-Located Informal Entrepreneurial Community

Study 1 and previous work on novice entrepreneurs (Hui, Greenberg, & Gerber, 2014) highlight how both distributed and co-located informal communities are used to support skill development in authentic workplace contexts. Study 1 seeks to understand how the design of informal ***co-located*** communities supports scaling of skill development in the absence of formal guidance. The study uses participatory observation and interviews, and draws from theories of apprenticeship and social cognitive theory, to develop a framework for how novice entrepreneurs in an entrepreneurial makerspace leverage the socio-technical affordances of the community to develop entrepreneurial skills and self-efficacy. Findings from these studies have broader implications for how to scale skill development in informal workplace communities in general, where a growing proportion of today's professionals are choosing to work (Florida, 2004).

Study 2: Apprenticeship in a Distributed Informal Entrepreneurial Community

The motivation for this study was to understand how the design of informal entrepreneurial communities supports scaling of skill development in the absence of formal guidance. The study draws from theories of apprenticeship and co-regulated learning, and presents an emergent theory of distributed apprenticeship, which describes how the socio-technical affordances of a ***distributed*** informal workplace community allows novices to seek and combine instruction from multiple sources to simulate the benefits of dedicated expert instruction. Based on interviews

with 47 crowdfunding entrepreneurs and observations of the online crowdfunding community, the findings highlight how distributed apprenticeship is instantiated in the context of crowdfunding, and highlights design implications for how crowdfunding platforms and support tools can better support skill development.

Study 3: IntroAssist: A Tool to Support Writing Introductory Help Requests

In Study 3, I design, develop, and evaluate a tool the scaffolds the writing of introductory complex help requests. The tool design is informed by findings from Study 1 and 2, which highlight the challenges with relationship development to access knowledge and resources. Findings from the tool evaluation have implications for related work in help-seeking in HCI, primarily regarding how to support the skill and self-efficacy development of the help seeker. Results show that the tool significantly improves the quality of help requests being sent by novice entrepreneurs and the likelihood that they will send these requests.

These studies form the remainder of the dissertation. ***Chapter 2*** grounds the studies in related work in human-computer interaction, learning sciences, and management. ***Chapter 3*** presents Study 1 on skill development in the co-located informal entrepreneurial community of a new makerspace. ***Chapter 4*** presents Study 2 on skill development in the distributed informal entrepreneurial community of crowdfunding. ***Chapter 5*** presents the design and evaluation of an online tool that scaffolds complex help-seeking for novice entrepreneurs. ***Chapter 6*** discusses contributions of this work to fields of human-computer interaction, management, and learning sciences. ***Chapter 7*** concludes this work and outlines plans for future work.

2. RELATED WORK

Communities provide opportunities to develop skills by interacting with a diverse range of individuals. I build on related work in entrepreneurship, human-computer interaction (HCI), management, and learning sciences to understand how people leverage social technologies to combine instruction from distributed sources in the absence of dedicated expert instruction.

2.1 Communities of Practice in Entrepreneurship

Although scholars argue that the act of discovering entrepreneurial opportunities is a solitary endeavor, the exploitation of entrepreneurial opportunities is highly social (Shane, 2003). Entrepreneurs work in teams, form alliances, and seek feedback in order to benefit from other people's perspectives and skillsets. Traditionally, entrepreneurs describe being motivated to collaborate in order to maintain a competitive advantage over other peers, and therefore rarely share their best practices with the public (Shane, 2003). More recently, management and HCI scholars have described how engagement in informal entrepreneurial communities have begun to change how entrepreneurs interact with each other to identify, develop, and deploy new products, processes, and services (Franke & Shah, 2003). I define informal entrepreneurial communities broadly, inspired by communities of practice literature (Wenger, 1999), as any distributed or co-located community of people who perform some or all parts of entrepreneurial work together or in parallel without formal guidance (e.g. leader, set curriculum).

Management scholars describe how lead innovators—people who address their own user needs by designing or re-designing products and processes (von Hippel, 1986, 1988)—join informal entrepreneurial communities, such as online and offline special interest groups, to seek

assistance in developing new products, many of which are eventually manufactured and commercialized (Franke & Shah, 2003). Those who received community assistance, through information, feedback, and labor support, are more likely to develop products that diffuse beyond their community network (Franke & Shah, 2003). Unlike traditional perceptions of entrepreneurs, members of these communities are not driven to make monetary profit, choose to freely share valuable work information, and participate in the community in order to have fun and interact with people with similar interests (Franke & Shah, 2003). Related work explains that entrepreneurs are increasingly choosing to share work information with potential competitors in order to benefit from social interactions that may inspire improvements, lower rivalry, and increase reciprocity and personal reputations within their professional network (Harhoff, Henkel, & Von Hippel, 2003; Slotte-Kock & Coviello, 2010) a behavior some people call "coopetition" (Bengtsson & Kock, 2000).

Similar values have been observed in co-located informal entrepreneurial communities, like makerspaces and hackerspaces, where researchers describe how values of social support, combined with easier access to manufacturing technologies, are creating new pathways to performing entrepreneurship (Lindtner et al., 2014; Toombs, Bardzell, & Bardzell, 2015). The grassroots informal nature of many makerspaces and hackerspaces motivates community members to take responsibility for each other's wellbeing (Toombs et al., 2015), such as volunteering to onboard new members, sharing skills (Taylor, Hurley, & Connolly, 2016), and being transparent about one's work processes (Kuznetsov & Paulos, 2010). This environment of social support encourages greater exploration (Tanenbaum, Williams, Desjardins, & Tanenbaum, 2013) and a sense of empowerment (Fox, Ulgado, & Rosner, 2015; Grimme, Bardzell, &

Bardzell, 2014; Hurst & Tobias, 2011; Ladner, 2015; Sun, Lindtner, Ding, Lu, & Gu, 2015), both of which are needed to develop new innovations under the often risky and stressful nature of entrepreneurial work.

These values of social support have also extended to the way entrepreneurs use online social technologies to seek financial, social, and human capital. I define "social technologies" as tools or systems that allow people to communicate, interact, and/or share information with each other. HCI researchers studying online Do-it-Yourself (DIY) communities describe how members interact with each other through community email lists and forums to seek inspiration for projects, learn new skills, and share feedback (Kuznetsov & Paulos, 2010). Management researchers describe how entrepreneurs using online marketplace platforms, like Etsy, share business advice and product feedback, which is particularly useful for novice entrepreneurs (Kuhn & Galloway, 2015). Similarly, my early work on crowdfunding communities has outlined how crowdfunding entrepreneurs leverage social technologies to identify product ideas, seek feedback, connect with manufacturers, and develop a consumer base (Hui, Greenberg, et al., 2014).

While previous work describes what resources are acquired in which types of communities, I seek to understand *how* people leverage the socio-technical affordances of informal entrepreneurial communities for skill development. Early work on communities of practice suggest that much learning occurs through emergent interactions between community members (Brown, Collins, & Duguid, 1989). However, little work has been done to understand under what circumstances these social opportunities for skill development arises, how they can be better facilitated, and what is the role of socio-technical systems in this process.

2.2 Social Technologies to Support Learning in Online Communities

Learning environments with social interaction have long been shown to support retention, critical thinking skills, and motivation to study (Hadwin, Järvelä, & Miller, 2011; M. K. Smith et al., 2009; Wenger, 1999). Social technologies provide avenues to support learning in online communities, such as inquiry through social Q&A platforms (Adamic, Zhang, Bakshy, & Ackerman, 2008), expert recommender systems (McDonald & Ackerman, 2000), social search tools (Morris & Horvitz, 2007), massive open online courses (MOOCS) (Brooks, Thompson, & Teasley, 2015; C. Kulkarni et al., 2013), and social media sites, like Facebook (Lampe, Wohn, Vitak, Ellison, & Wash, 2011). I define social technologies as any type of online tool or platform that provides affordances that allow people to communicate, interact, and/or share information with each other (Kraut & Resnick, 2012). Social technologies are distinct from technologies in general as the term technology has previously encompassed machines and equipment that facilitate or take the place of human labor (Peter M. Blau, Falbe, McKinley, & Tracy, 1976; Orlikowski, 1992; Woodward, 1958). Rather, I take a socio-technical perspective, which describes technologies in a social context and "a product of ongoing human action, design, and appropriation" (Orlikowski, 1992).

HCI researchers have developed specific social technologies for educational contexts to better facilitate apprenticeship between students and mentors. For example, Rees Lewis et al. developed a system that connects novice designers and professional coaches in extracurricular project-based learning environments (Rees Lewis, Harburg, Gerber, & Easterday, 2015). Zhang et al. developed a set of community-based tools to support interactions between student design teams working towards similar project goals (H. Zhang, Easterday, Gerber, Lewis, & Maliakal,

2017). In addition, researchers studying MOOCS have found that those that offered a social component, such as peer discussion and evaluation, have greater student retention (Krause, Mogalle, Pohl, & Williams, 2015; C. Kulkarni et al., 2013). However, most of these systems assume a designated set of instructors to facilitate the learning process. Instead, I study online workplace contexts where novices must identify and connect with instructors. Limited access to dedicated expert guidance is a common problem in informal workplace contexts, like entrepreneurship, where few people have the exact set of expertise and/or time to mentor others through the entire work process.

A handful of HCI researchers have studied how learners use social technologies to coordinate and combine instruction from distributed sources in order to mimic the benefits of dedicated expert instruction. Researchers have primarily used the lens of collaboration and coordination to study information access from distributed sources. For instance, Gray et al. (2016) investigated how crowd workers—people who perform tasks online for pay—collaborate with other crowd workers to manage administrative overhead, share information about tasks and requesters, and even perform the work itself (Gray, Suri, Ali, & Kulkarni, 2016). Lampe et al. (2011) found that students use Facebook to coordinate outside the classroom to organize study groups and learn more about course processes (Lampe et al., 2011). The process of learning, while similar to collaboration and coordination, requires different theoretical frameworks that focus more on how people acquire knowledge to perform tasks rather than how they perform the tasks themselves.

Evidence of a distributed approach to skill acquisition has recently been described in online creative communities where members use online platforms to look at other projects for

inspiration and seek advice through peer discussions. Marlow and Dabbish found that novice and expert designers on Dribble, a online community for graphic designers, solicited feedback on their work through online comments and looked at peer work for inspiration (Marlow & Dabbish, 2014), while others similarly found that artists sought feedback and took inspiration from others in online fan fiction communities (Campbell et al., 2015; Evans et al., 2017; Fiesler, Morrison, Shapiro, & Bruckman, 2017).

Unlike these initial studies, I study how people use multiple online platforms (rather than a single platform) to perform complex work. Complex work is likely to involve using multiple platforms because it allows people to acquire a diverse set of skills and resources at different project stages. For instance, crowdfunding work is particularly complex in that it involves acting as a publicist on social media platforms, a project manager on team-management platforms, and financial manager on crowdfunding platforms, in order to coordinate activity with hundreds to thousands of supporters (Hui, Greenberg, et al., 2014). Meeting the skill development needs of increasingly complex jobs is an a key goal in today's economy and a primary motivation for performing this study (Pew Research Center, 2016).

2.3 Social Technologies to Support Learning in Formal Workplaces

Research on learning through social technologies in the workplace has primarily focused on formal workplace contexts (Hollingshead, Fulk, & Monge, 2002; Orlikowski, 1992) where organizations have the resources to design and develop tools primarily to connect workers. Early research on knowledge sharing in organizations describes the use of "intranets", "online knowledge communities" (Hwang, Singh, & Argote, 2015), and "enterprise social media"

(Leonardi, 2015) to identify and locate experts outside usual communication networks, such as in other departments and work groups (Hollingshead et al., 2002; Rulke & Galaskiewicz, 2000). Being able to use social technologies to search for and communicate with any peer was seen as particularly useful for distributed work groups that had limited opportunities to meet or maintain awareness of each other in person (Hollingshead et al., 2002; Olsen & Olsen, 2000). More recently, Leonardi and Meyer (Leonardi, 2015; Leonardi & Meyer, 2015) found that social technologies that afforded third party observation of online conversations improved accuracy of employee metacognition—knowledge of who knows what and who knows whom (Ren & Argote, 2011). Enterprise social technologies also make it easier to establish awareness of others skills and connections especially in organizational contexts where people are typically unaware of the majority of communication occurring around them (Ackerman, 1998).

Unlike employees in an organization, who identify as working together for a company and are paid to perform work to further company progress, non-traditional workers in informal contexts (e.g. entrepreneurs) are often in competition with each other and therefore have little to no obligation to help their peers (Bhide, 2000). Furthermore, unlike large established institutions which provide access to experts, business advisors, and various instructional tools, entrepreneurs not part of a school or accelerator program must rely more on personal means, such as prior experience (Dew, Velamuri, & Venkataraman, 2004; Grant, 1996) or communicating with friends, family, and extended ties, to access needed resources (Hite, 2005; Hite & Hesterly, 2001; Kaish & Gilad, 1991; Ozcan & Eisenhardt, 2009; Pfeffer & Salancik, 2003). This lack of a formal support network poses unique challenges for entrepreneurs who seek to access instructional resources.

2.4 Apprenticeship

Apprenticeship has long been considered one of the most effective ways to learn new skills in workplace environments because instructors closely monitor and support novice learning through guided participation (Collins, 2006). Traditional apprenticeship is mainly useful for teaching easily observable tasks, such as shoemaking or farming, situated in workplace contexts (Collins, Brown, & Holum, 1991; Lave & Wenger, 1991). In traditional apprenticeship, the primary methods of instruction include modeling, coaching, and scaffolding. Modeling involves an expert performing a task so that learners can watch and emulate their processes; Coaching involves having someone provide feedback and advice as they see fit or as problems arise; Scaffolding refers to the supports a coach may provide and slowly remove to facilitate increasingly independent performance (Reiser, 2004). When novices encounter unanticipated barriers, as is common in workplace environments, the instructor models behavior and provides relevant and timely advice specific to the workplace context.

However, the small instructor-to-learner ratio of traditional apprenticeship makes it difficult to scale. To address this issue, Collins and colleagues first developed cognitive apprenticeship as a way to apply apprentice-style instruction to classroom contexts (Collins et al., 1991). This would allow for two primary benefits: 1) scaling apprenticeship to classroom-sized communities (i.e. 30 students), and 2) applying methods of apprenticeship to teach the cognitive processes of more broadly applicable skills, such as reading and math. In order to teach the cognitive aspects of generalizable skills, like reading and math, in the classroom, Collins expanded the methods of traditional apprenticeship to encourage instructors to voice their thought processes and for learners to do the same. In his words, “The teacher's thinking must be

made visible to the students and the student's thinking must be made visible to the teacher. That is the most important difference between traditional apprenticeship and cognitive apprenticeship" (Collins et al., 1991). For cognitive apprenticeship, Collins adopted the core methods of modeling, coaching, and scaffolding, in addition to adding methods of articulation, reflection, and exploration. Instructors are not only expected to visually guide novices through modeling, coaching, and scaffolding, as with traditional apprenticeship, but also provide cognitive guidance by verbally articulating problem solving processes. Articulation involves asking the learners to explicitly describe their knowledge, reasoning, and problem solving processes as they perform the task (J. Bransford, 2000). Reflection involves encouraging the learner to evaluate their performance by comparing their work to a mental model or others' work, and identifying opportunities for improvement (Schön, 1983). Exploration requires performing the task in an authentic environment with minimal to no guidance.

Like Collins, our goal is to understand how the benefits of apprenticeship instruction can be applied to more scalable learning environments, like online workplace communities, where novices have the opportunity to interact with hundreds or thousands of others performing similar work. As people increasingly turn to online communities and social technologies to develop skills and careers, I seek to understand through what social mechanisms novices develop skills in online communities. Unlike traditional and cognitive apprenticeship, novices in informal workplace communities typically have limited to no access to dedicated expert instructors (e.g. schoolteacher) and primarily interact with a distributed network of non-expert instructors (e.g. peers, supporters, domain experts) accessible through community social technologies.

3. APPRENTICESHIP IN A CO-LOCATED INFORMAL ENTREPRENEURIAL COMMUNITY

3.1 Introduction

Novice entrepreneurs are less likely to have access to existing professional social networks and therefore face higher barriers to making new connections. This study seeks to understand how people leverage co-located socio-technical communities to establish relationships for skill development. Specifically, ***How do the socio-technical affordances of co-located informal entrepreneurial communities support apprenticeship in the absence of dedicated expert instructors? (RQ1)***

Over the past two years, I have established relationships with leaders of makerspaces in Chicago and Seattle to understand how their communities are moving beyond places of just tinkering to sites of professional development and entrepreneurship (Hui & Farnham, 2016; Hui & Gerber, 2017). While many still treat makerspaces as third places—spaces outside the workplace and home that foster socialization and greater creative interaction (Oldenburg, 1999)—more people are starting to use makerspaces as places to develop professional skills and launch new ventures. If we visit a makerspace today, we might see a person building an LED lamp for his home, but we might also see a person building a series of tables she intends to market on her personal website, an artisan entrepreneurship platform like Etsy ("Etsy," n.d.), or a crowdfunding platform like Kickstarter ("Kickstarter," n.d.-b). Already, makerspaces have been the birthplace of some of today's most successful ventures, like the Pebble Smartwatch, Makerbot 3D Printer, Oculus Rift, and Nest Thermostat (Geyer, 2015). Yet, our understanding of this expanding professional role of makerspaces is limited.

HCI scholars are calling for further research to understand how makerspaces become sites of entrepreneurship (Lindtner, Greenspan, & Li, 2015; Lindtner et al., 2014). Previous work on makerspaces has primarily focused on how they serve social and civic needs, such as encouraging making activity among those who often lack access (Buechley & Hill, 2010; Cervantes & Nardi, 2010; Fitton, Read, & Dempsey, 2015; Hook, Verbaan, Durrant, Olivier, & Wright, 2014; Litts, 2015; Richard, Kafai, Adleberg, & Telhan, 2015; Rogers et al., 2014) and serving as places of personal empowerment (Fox et al., 2015; Grimme et al., 2014; Hurst & Tobias, 2011; Ladner, 2015; Sun et al., 2015). However, an understanding of how makerspaces support skill development of entrepreneurs is needed to design makerspaces beyond places of just tinkering.

I take a socio-technical perspective to understand how entrepreneurs leverage a makerspace's social and technological resources to promote peer support, transparency, exploration, and empowerment—community-focused values observed in maker cultures (Fox et al., 2015; Grimme et al., 2014; Hurst & Tobias, 2011; Lindtner et al., 2015; Sun et al., 2015; Taylor et al., 2016; Toombs et al., 2015). These values, paired with socio-technical supports to observe and work alongside people of diverse skillsets, provides a unique opportunity to develop skills and confidence in an innovative and supportive environment before launching larger-scale ventures.

Observing the progression of a makerspace from an empty warehouse to a place of thriving, social practice allowed us to study how relationships were formed, values established, and technologies adopted to facilitate skill development in entrepreneurship. I performed a five week long participant observation of a new entrepreneurial makerspace in addition to 22 semi-

structured interviews with members, informal observations of online communication channels, and follow-up observations and interviews with the makerspace founder, to understand how people develop entrepreneurial skills in a makerspace setting, and the role of social technologies in this process. I build on prior research on maker communities, entrepreneurship, and social computing by performing one of the first studies identifying how people leverage the socio-technical resources in a makerspace to encourage entrepreneurial development, and how this entrepreneurial development benefits from community-focused values commonly observed in maker cultures.

Results from this work were published and presented at the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing (Hui & Gerber, 2017).

3.2 Makerspaces as Sites of Entrepreneurship

Makerspaces offer sites for accessible entrepreneurship apprenticeships by offering in-person opportunities to socialize with knowledgeable peers while gaining hands-on making experience (Kauffman Foundation, 2008). Toombs et al. describe how makerspaces often rely on community-based values to survive and thrive (Toombs et al., 2015). Community-based values observed in makerspaces include social support (Taylor et al., 2016; Toombs et al., 2015), transparency (Kuznetsov & Paulos, 2010; Lindtner et al., 2015), exploration (Grimme et al., 2014; Tanenbaum et al., 2013), and empowerment (Fox et al., 2015; Grimme et al., 2014; Hurst & Tobias, 2011; Ladner, 2015; Sun et al., 2015), all of which are useful for fostering apprenticeship activity. A more open and supportive community promotes observation, interaction, and self-efficacy development during early stages of entrepreneurship when novices

often work alone and with little guidance (Davidsson & Honig, 2003; Hoang & Antoncic, 2003; St-Jean & Audet, 2012).

I define the making practices occurring in makerspaces broadly. While makerspaces may describe their set of activities (e.g. craft, repair (Houston et al., 2016; Roedl, Bardzell, & Bardzell, 2015), hacking (Fox et al., 2015; Lindtner et al., 2014)), Lindtner et al. argue that these practices should be viewed as "shared family resemblances" where the differences between different makerspaces' particular activities and goals only adds deeper meaning to how we view making (Lindtner, Bardzell, & Bardzell, 2016).

Historically maker communities have been wary of supporting goals of entrepreneurship, such as making for profit, believing that they oppose principles to combat consumerism and profit-driven commercialization (Fox et al., 2015; Lindtner et al., 2016, 2014; Roedl et al., 2015). Yet, recent work have started to describe how entrepreneurially focused makerspaces are able to promote business development while maintaining community-focused values and fostering an open and creative atmosphere (Lindtner et al., 2016, 2015, 2014). In a 4-year long ethnography of hackerspaces in China, Lindtner et al. describe how these places help bridge China's emerging creative activity to the large-scale fabrication industry to help turn more ideas into a reality (Lindtner et al., 2014).

Entrepreneurially focused makerspaces are not yet widespread, providing a prime opportunity to study how these makerspaces are being designed and run to foster entrepreneurship in a way different from more established avenues like schools and business accelerators. Our study focuses on an entrepreneurial makerspace in the United States where people are interested in hands-on making and selling of one's products.

3.3 Methods

3.3.1 Research Setting

To address the research question, I performed a 5-week long participant observation of a new Chicago-based makerspace from July-August 2015. Data collection took place at ORD1 (alias chosen based on Chicago's airport code), which launched in July 2015. The goal of ORD1 was to create a place where people could come together and have the tools and social resources to develop new products and services. ORD1 was unique from many existing makerspaces in that it encouraged entrepreneurial activity and was created as a 5-week long experiment to test the viability of developing a longer-term makerspace.

The space was a 4,300 square foot one-story building with an open floor plan located in an urban area at street level in Chicago. The space was previously a meatpacking warehouse and was scheduled to be torn down to build condominiums. Because the space was vacant during the months prior to teardown, the makerspace founder convinced the landlord to use the space for the experimental pop-up makerspace, leasing him the space for one dollar. Due to the success of ORD1, the setting of this community has been moved to another more permanent location in Chicago. During data collection, ORD1 was typically open from 10am to 10pm, seven days a week.

3.3.2 People

Three months prior to opening, the founder of the makerspace invited 40 people from Chicago who represented a diverse range of skills and creative interests to join ORD1. Those invited included professional graphic designers, local community builders, design entrepreneurs,

architects, teachers, and industrial designers. Ages ranged from 25-60 years old. Once ORD1 opened its doors, the founder invited friends-of-friends to join, as well as curious passerby's. By the end of the 5-week long data collection period, 103 people (27 female) were included on the email list as people who were welcome to work in the space. Based on a daily attendance sheet, 76 (20 female) of the 103 people visited the space at least once, while 35 (15 female) visited more than twice. In a Kickstarter campaign that raised $10,000 during the months prior, the founder encouraged contributions in exchange for makerspace access, but then decided to charge no fee to new members once the space opened.

Between 5-15 people would work in the space at one time. The founder gave a personal tour to each of the new members, but there was no certification process or official orientation as members were expected to reach out to each other if they had questions. Three local high school students served as "interns", taking attendance, keeping the space organized, and watching over the space when the founder was absent in exchange for a stipend and access to the space's resources and community.

The founder of the makerspace had extensive experience developing startups to support creative entrepreneurs. He invested $40,000 into buying some initial machinery and tools for the space. The founder was in charge of opening and closing the space, managing space facilities (e.g. electricity, water, Wi-Fi), giving tours, managing relationships with the press, and organizing events. While members of the space tried to help out when they could, the founder often described being overworked and low on sleep.

3.3.3 Physical Resources

ORD1 included six 3-D printers, two table-top mills, one laser cutter, one table saw, one cabinet saw, one drill press, a plotter, soldering irons, and other basic tools (e.g. hammers). Because of the founder's connections and reputation in the entrepreneurship community, companies like Makerbot, Bosch, and Inventables, agreed to loan machinery. Gravel parking lots were located to the west and south of the building for outdoor and larger projects. A local company loaned their renovated airstream, which was parked in the adjacent lot and served as a "clean space" to work.

3.3.4 Social and Web Technologies

The founder created a group email list, Slack account, and Facebook Page to promote both community socialization and publicity before, during, and after the space was open. The email list was primarily used for announcements, such as public events. The Slack account was more commonly used for community socialization and included 14 channels, such as #general, #documentation, #events, #ideas, #maintenance, and #random. Each channel had its own unique purpose and allowed people to subscribe to different types of conversations. For example, #documentation was a place for people to post pictures of their work process, while #maintenance was used to announce when certain machines were in need of repair. There was limited Wi-Fi in the space provided by a portable Internet device lent by one of the ORD1 members. In addition, the ORD1 founder encouraged members to post photos of activity on social media, tagging the location of ORD1 and using the ORD1 hashtag. The public posts on social media and the Kickstarter page served as publicity material for the community.

3.3.5 Data Collection

I visited the space for 20 hours each week (total of 97 hours), performed field work by taking field notes describing member interactions and work processes, took photographs, had informal conversations, helped with people's work when needed, facilitating member interactions, and leading community tours when the founder was absent or busy. Field notes were taken both in the space during free time and after being at the space each day. The space was originally publicized through a Kickstarter campaign to raise funds for a zine, a small-circulation self-published magazine that would document the growth of the community. Similar to other participatory research approaches performed in previous makerspace studies (Fox & Rosner, 2016), the researchers' roles also included documenting what was happening in the space in order to inform content for the zine. All members knew about the zine and research project and agreed to be photographed.

During data collection, our research question was not yet clearly formed, although we were interested in understanding how the social aspect of the makerspace supported entrepreneurial activity broadly. Therefore, I took particular note of how members interacted with each other, for what purpose, what tools were used for these interactions, and how these interactions informed their work. For instance, rather than just focusing on an individual's relationship with tools, as described in previous CSCW work on creative spaces (Cheatle & Jackson, 2015), I sought to more deeply understand how an individual's work was informed by interpersonal interactions happening in the space and online.

Following observations, I also conducted interviews with 22 of the most active community members. Interviews followed a semi-structured format with questions around what

skills they learned, who they came to know, how it affected their confidence, and their use of social technologies such as Slack, Instagram, Facebook, and the listserv. Interviews lasted for 30 minutes on average and occurred in person and by phone depending on the interviewee's availability. All interviews were recorded and transcribed.

I continued to follow up with the next iteration of ORD1, henceforth referred to as ORD2, by monitoring the social media channels (Slack, Facebook, and Instagram) and having informal conversations with the makerspace founder throughout the year as he prepared for and launched ORD2. I consider these conversations as secondary data to supplement our understanding of how activity in ORD1 informed the next version of the community.

3.3.6 Data Analysis

I performed a thematic analysis (Boyatzis, 1998; Braun & Clarke, 2006) to analyze the data over three rounds of coding. The data was first analyzed by two researchers who read over the interview transcripts and field notes, making a list of general themes that emerged, such as entrepreneurship, learning, self-efficacy, community development, and social technologies. This produced an initial list of 14 codes. In the second round of coding, I analyzed each theme more in-depth by identifying more specific codes. For example, under the theme "learning," I identified codes of "help-seeking," "mentorship," "workshops," and "observation." I performed a third round of coding informed by the *cognitive apprenticeship* to identify mechanisms of skill acquisition. I used the categories within cognitive apprenticeship to further code the data around how ORD1 members developed entrepreneurial skills in a social environment. All names have been changed for anonymity.

To reiterate, cognitive apprenticeship outlines six mechanisms of skill acquisition: modeling, coaching, scaffolding, articulation, reflection, and exploration. *Modeling* involves an expert performing a task so that learners can watch and emulate their processes (Bandura, 1977). *Coaching* involves having someone provide feedback and advice as they see fit or as problems arise (Collins, 2006). *Scaffolding* refers to the supports a coach may provide to facilitate learning, such as flash cards or step-by-step instructions (Reiser, 2004). *Articulation* involves the learners explicitly describing their knowledge, reasoning, and problem solving processes as they perform the task (J. Bransford, 2000). *Reflection* involves the learner looking back at their finished work to identify opportunities for improvement (Schön, 1983). Lastly, *exploration* is when the learner performs the skill in an authentic environment with few to no supports. Together, these mechanisms outline the multiple approaches to facilitating effective apprentice-like learning. I describe which of these mechanisms were most prominent in our observations and interviews to describe how entrepreneurial skill acquisition occurred in ORD1.

3.4 Findings

Developing an entrepreneurial makerspace goes beyond inviting people with entrepreneurial goals. It involves creating opportunities offline and online to develop skills and self-efficacy in a range of entrepreneurship tasks, from manufacturing to marketing, all while engaging in a meaningful social context. Based on over 10 years of previous experience developing online tools for entrepreneurial makers, the ORD1 founder identified a need to create a physical community that included the benefits of social technologies (e.g. quick access to peers, distribution) with the benefits of a physical space (e.g. face-to-face interactions, manufacturing).

He realized that people needed access to open participatory systems both online and offline to support their entrepreneurial development.

I analyze entrepreneurial skill development through the cognitive apprenticeship framework (Collins, 2006). Because there were no formal mentor-apprentice pairings as are typical in apprentices, I use this framework to understand how members of the space combined distributed instruction from multiple members online and offline to experience *modeling*, *coaching*, *scaffolding*, and *exploration*—the most prominent examples of cognitive apprenticeship methods represented in our data. I present the findings in order of prevalence. And while I present each mechanism individually, in reality, there were instances of overlap.

3.4.1 Modeling

I found that the transparency and exploratory nature of ORD1 afforded by the open floor plan and community use of social technologies provided opportunities to develop skills via modeling. Modeling in cognitive apprenticeship involves learning a task by observing expert behavior (Collins, 2006). By observing experts offline in the space and online through social technologies, members were able to try out new skills and follow along with expert thought processes. For instance, a self-described product designer, explained how being immersed in ORD1 provided greater exposure to new methods of making that he had not encountered:

> *"It's hard to find other people who are kind of the same way. So, it was an opportunity to be together with other people…You learn things that apply that you don't necessarily think to try to learn through normal channels."*

Development Type	Mechanism	Examples from ORD1	Impact on ORD2 Design
Entrepreneurial Skill Development	Modeling	*Offline:* Watching others use certain machines. *Online:* Reading others' project process on Slack.	- Open space layout maintained - Social media for project sharing still encouraged (e.g. official Instagram, Facebook Page, and hashtags) - Public offline or online project "journaling" to be encouraged
	Scaffolding	*Offline:* Attending community-member run workshops *Online:* Reading community-posted tutorials in online communication channels	- Further workshops to be held on entrepreneurial-focused topics (e.g. crowdfunding) - Work area organized in order of most to least approachability (e.g. laptop area to table saw)
	Coaching	*Offline:* Seeking informal advice from members working nearby *Online:* Using online channels to ask questions and advice to other members	- Open space layout maintained - Loudest machine tools kept farthest away and sound-dampened from conversational work areas - Social media use still encouraged for Q&A
	Exploration	*Offline:* Manufacturing small product runs for a crowdfunding campaign *Online:* Using social media to promote one's ventures	- Membership marketed to soon-to-graduate and recently-graduated artists, designers, and engineers - Partnerships being developed with other entrepreneurial education non-profits - Designated photo and video production area added to support publicity efforts - Social media use for marketing encouraged

Table 1: The impact on the design of ORD2.

For instance, Lee, a member who had launched over four successful Kickstarter campaigns wanted to learn better prototyping techniques. He identified a member, an art student, skilled at prototyping after watching him use the 3D printers and seeing photos of his finished work on Instagram. Lee asked to work alongside him at the 3D printers asking questions as needed, eventually creating a prototype of a drinking product, which he used to raise over $40,000 on Kickstarter. In return, the art student was able to witness how a more experienced entrepreneur turned his creative work into a viable product.

While modeling allowed people to observe more experienced others, I noticed a tension in terms of how people described the social and open aspect of the space. Members enjoyed being around other creative people, but it was sometimes distracting. The open layout provided a way for everyone to see what others were doing, but also sometimes limited social interaction

and new member onboarding because the scattered presence of high-power tools were intimidating and limited conversations with their sound.

This dichotomy between freedom and structure created by the open layout seemed to both promote and inhibit skill sharing, especially when people were often tied to deadlines. One professional furniture designer described this dynamic particularly well:

> *"I showed up at this space with some trepidation because of being drawn out into the world on a daily basis when I'm used to being head down working on things. Bouncing off different personalities throughout the day was a bit scary because one of the things that it does is it draws you away from what you're doing."*

Many of the members are self-employed and typically work from home where there are few distractions, but also few opportunities to learn new skills from others in person. He then goes on to say:

> *"Ideally, that is sort of developed into more of a sharing process, where I can stop for a second … That little turn of concentration kind of, it's more fruitful in the end than just hammering nonstop with my head down. While it's a tradeoff of time, I think that in the end the bonus is there. It will eventually help develop what I'm doing."*

This member became inspired by others' 3D printed work and prototyped ways to include 3D printing in the wood furniture that he sold.

While the social aspect of the space was sometimes distracting, members found that the transparency of the space and online channels provided an opportunity to observe the language and work processes of other members. When members could not be in the space, online

conversation channels, such as Slack and a Facebook Page, provided an opportunity to peripherally participate (Lave & Wenger, 1991) in conversations between community members.

> *"I wanted to know what everyone else was doing and wanted to see like what the dialogue was… There were people I never met, but I kind of knew what they were talking about on Slack and was able to find out about questions people had that may have helped me."*

One member who was transitioning into a more entrepreneurial maker career passively watched conversations on Slack to better understand the range of tasks an entrepreneurial maker might participate in:

> *"It's really just this hive mind of information. There's people discussing things that you didn't think of until after they've already gotten all the way through it, and all you have to do is look it up to see the entire conversation."*

These online communication technologies, which are more popularly used for team management, were particularly useful in this makerspace context for learning entrepreneurial skills that were harder to observe in the physical community environment, like crowdfunding. For instance, different members who were crowdfunding their projects would share links to their own and others' Kickstarter projects, which provided online models of how to run on online fundraising campaigns. These online examples of marketing were supplemented with offline conversations, which I further discuss in the Coaching section.

The ORD1 founder considered what he called "transparency" to be one of the most important aspects of the space. By "transparency," he meant being able to easily see and watch what other members were working on. He encouraged transparency online by asking all members to upload a photo, introduce themselves, and share their project progress on Slack. In

the next iteration of the space (ORD2), he decided to maintain an open layout and use of social technologies, like Slack and Instagram, to allow people working on different projects to easily observe each other.

3.4.2 Scaffolding

We found that social technologies helped to scale and extend scaffolding—supports provided to learners to help them carry out a new task (Collins, 2006; Reiser, 2004)—beyond the physical space. The scaffolding supported entrepreneurial skill development by providing step-by-step guidance in what sometimes felt like an unstructured environment.

By using Slack, people who had different schedules could share expertise with novices asynchronously. These online channels allowed members to share heuristic strategies (i.e. tricks of the trade) with each other even if they were not in the space at the same time.

> *"On Slack he had posted, I guess there were the setting parameters… So, like for instance, I cut magnet…I was able to look at the settings that were similar materials and kind of try to come up with the settings I would use when I was in the space. So it's kind of nice to have it as kind of the backbone or kind of the dialogue that was happening along with being in the space."*

Because some members found visiting the space too time consuming or overwhelming, these online channels gave them an opportunity to keep track of knowledge being shared without having to physically visit every day.

Scaffolding also occurred in more traditional cases offline. Members volunteered to hold workshops where they would scaffold the learning process by giving step-by-step instructions,

providing practice projects, and allowing people to perform skills on their own with as-needed support. Attendance at these workshops ranged from three to twelve people and provided an opportunity for members to gain experience with new tools and processes. While most workshops were on how to use certain tools, like the 3D printers and table saw, the success of these workshops has convinced the ORD1 founder to hold future entrepreneurial workshops on topics like crowdfunding and marketing in ORD2.

This effort to host workshops and document knowledge online spoke to a sense of mutual responsibility among community members. In order to foster this community culture, the founder posted community rules on the wall facing the main entrance: “Be helpful, Be fun, Be respectful”. Scaffolding, facilitated by community values of social support, provided greater opportunities to develop new skills needed to carry out entrepreneurship.

3.4.3 Coaching

I also observed various instances of members providing coaching to each other—giving advice and feedback on work in progress. The openness to help others was particularly useful for novices in the space who had limited experience developing and marketing products. While some members were known to be more experienced than others on manufacturing or marketing, I observed bi-directional coaching activity. For instance, a family of three who developed a clay 3D printer together over the 5-week period partnered with a product designer in the space to run a Kickstarter campaign. Similarly, a high school student in the space described how interacting with more entrepreneurially minded people helped him learn skills like marketing, quality control, and public communication.

"[Brian] has taught us a lot too, and points of, you know, business. He's taught us how you've got to talk to people, how you've got to sort of give them a tour of the whole place…You know, you learn something from everybody that's come in through this door whether it's something small or something big."

Members developing consumer products for the first time learned from others about quality assurance practices, such as more efficient production processes or how to find high quality materials. For instance, one member was having difficulty finding durable, environmentally friendly material for a product he needed to make and distribute for over 80 people. Another member with over five years of experiencing designing and manufacturing consumer-quality products offered some advice.

"[My teammate and I] would buy yoga blocks from Amazon for all of our projects. We didn't like doing that because it's super wasteful…I think Tyler was the one who suggested a company who will cut it to the thickness we need …which limited a lot of the waste too."

However, the 5-week long period of ORD1 limited the extent to which members could develop high-quality production skills as many were testing experimental ideas that may or may not be further developed into a consumer product later on. For example, one member who built a canoe as an experiment is now working with a local organization to teach teens how to build their own canoes for neighborhood rivers. Others developed experimental pieces of furniture that have so far just been donated to the ORD2 space.

In addition to providing advice on making products, members with more entrepreneurial experience encouraged novices in ORD1 to publicize their work on social media. One member, who runs a college summer engineering/maker program, described how one of the most valuable

pieces of information shared with his students was the importance of promoting one's work online.

> *"He said, 'You know, you really need to be on LinkedIn and you really need to have a professional presence. It's great you have a room of tools, but you need a place where you can put out the things that you are working on because there's communities at large that care…The more they know about you in advance, the better.' That struck with my students, and I got a good three or four of them who were like, 'So how do I post my code? And how do I get this stuff out there?'"*

The use of online social technologies also enhanced coaching by helping people within the community identify who had what skills and foster relationship development between experts and novices. For instance, novice members found that being able to message more expert members through social technologies helped develop the trusting relationships needed for question asking and answering. One of the high school members described how he liked interacting with members both offline and online to reduce communication barriers.

> *"I think [Slack] definitely creates a bridge for us…You're able to communicate a lot faster, get in touch with people and kind of know people, because I mean talking to people in person and through online, I feel like, it's two different personas that you kind of learn from. So, it's unique, getting to know that person from social media and then in person."*

Similarly, another member described how the environment of social support and open communication motivated her to ask people questions even if she did not know them well.

> *"Everyone has to feel comfortable within that space to actually ask the questions, create a very safe environment. And also new people who are coming into the space also don't feel*

like they're a novice and at a handicap. So it's the community building that was exceptionally strong."

This emphasis on leveraging social technologies for publicity and relationship development further differed ORD1, an entrepreneurially focused makerspace, from other makerspaces that focus more on fostering self-contained offline environments of making (e.g. (Fox et al., 2015)).

3.4.4 Exploration

Complementary to coaching, ORD1 promoted skill development through exploration—the practice of using available tools and knowledge to perform a task with little guidance. At a public event, the founder expressed that there were few opportunities for entrepreneurial skill development, particularly for those with limited financial, social and pedagogical resources. This need motivated him to start ORD1, and was reiterated by student members in the community. Members who were students in local high schools and colleges expressed that they would no longer have studio access after graduation, which would prevent them from working on new ventures. They described how ORD1, plus various online entrepreneurial support tools, like crowdfunding platforms, provided a way for them to fund buying materials and test out ideas at a low cost. For instance, one member explained how ORD1 provided the resources to develop an initial low-run of his products for consumers before turning to large manufacturing plants:

“Manufacturers, they don't want to deal with us. We're making like 100, 200 at a time, and their setup for their lowest run is like 10,000. So why would they want to fit us in when they already have a client that they're going to make money off of? So it's that really low run use of machinery and equipment that I think is the most beneficial."

While manufacturing plants are a key part of product-focused entrepreneurship, novice entrepreneurs felt that they needed to test out their ideas on a smaller scale before investing in a large manufacturing order. Many others did not even want to use a manufacturer and preferred to hand-make each of their products. However, because renting physical space and buying one's own tools, such as a table saw, can cost thousands of dollars, makerspaces can provide a cheaper way for entrepreneurial makers to use these tools at a lower cost.

In addition to physical tool resources, ORD1 provided the opportunity for a diverse community of makers, artists, designers, and creatives, to form new project collaborations. For instance, three members formed a collaboration to develop a series of products for a local education program. One member, who had started his own design education program, approached two designers in ORD1 to create packaging for one of his education modules. The final product was eventually promoted on Kickstarter and raised over $49,000 in a month. Most other members participated in short-term interactions, like offering brief help with each others' hands-on work, but expressed the desire to establish longer-term project collaborations for future projects.

The makerspace founder recognized that ORD1 was providing unique resources to members who did not have the tools, space, and community support to experiment in a social and inclusive entrepreneurial environment. While the next ORD1 iteration involves a membership fee open to the public, the founder has been working with local colleges that have limited maker resources to develop potential partnerships around offering entrepreneurially-inclined students access to the space and community.

3.4.5 ORD1 as an Entrepreneurial Makerspace

I decided to study ORD1 because of the founder's expressed commitment to supporting entrepreneurial activity in a makerspace beyond providing "just a room with tools". ORD1 was not the first makerspace to support entrepreneurship (Lindtner et al., 2016, 2015, 2014), but it is one of few that clearly promotes entrepreneurship as part of its platform. On the community website, alongside promoting "exploring ideas," and "kinship," it also calls itself place where people can go to "start a business." Many consider ORD1 a hybrid between a business incubator, machine shop, and co-working space because it aims to provide access to machine tools, social learning, and entrepreneurial support.

Similar to other makers (Lindtner et al., 2014), ORD1 members were wary of the connotations associated with the word "entrepreneurship" because it is often associated with privilege and competition. In fact, most did not describe themselves as entrepreneurs despite performing entrepreneurial work—creating new products and services, marketing one's work, and managing finances (Chen, Greene, & Crick, 1998; Kazanjian, 1988; Miner, 1990; Shane, 2003). Rather, they defined themselves by their craft (e.g. designer, artist), where the entrepreneurial part of their work was seen more as means of acquiring funding. In agreement with previously uncovered values of resistance to authority (Toombs et al., 2015), members were motivated to make and sell their work as a way to combat consumption of mass-produced products. This was exemplified early on during the development of the space when members came together to build the makerspace tables and chairs, joking about the worst-case scenario– buying furniture from IKEA.

Unlike other makerspaces, where communities were described as more inwardly focused

(Fox et al., 2015), a core practice in ORD1 was developing professional reputations outside the space by publicizing one's work online and offline. Publicizing one's work is a key aspect of entrepreneurship, and members were intrinsically motivated and encouraged to share photos and updates of their projects. While communities of practice literature describes how one's identity with a community is primarily developed through interaction with community members (Wenger, 1999), I found that interactions with people outside the community also played an important role. This behavior is similar to those described by psychologists as reflective appraisal theory, which states that people develop impressions of themselves based on how they think others perceive them (Sullivan, 2013). This finding adds to social cognitive theory by highlighting how public validation can serve multiple purposes for building entrepreneurial self-efficacy. In the context of ORD1, members not only liked being praised for their work, but also felt that associating themselves with ORD1 in others' eyes made their professional identity more legitimate.

3.4.6 Design of ORD2

ORD 2 opened about a year after ORD1 closed in a more permanent location about 1 mile from the original ORD1 site. To further support entrepreneurial development, ORD2 includes a larger open space with a range of designated work areas, a wider range of entrepreneurial-focused workshops, a photo/video area for marketing, and continues to promote social media activity for publicity and project documentation. A summary of how activity in ORD1 influenced the design of ORD2 can be found in Table 1.

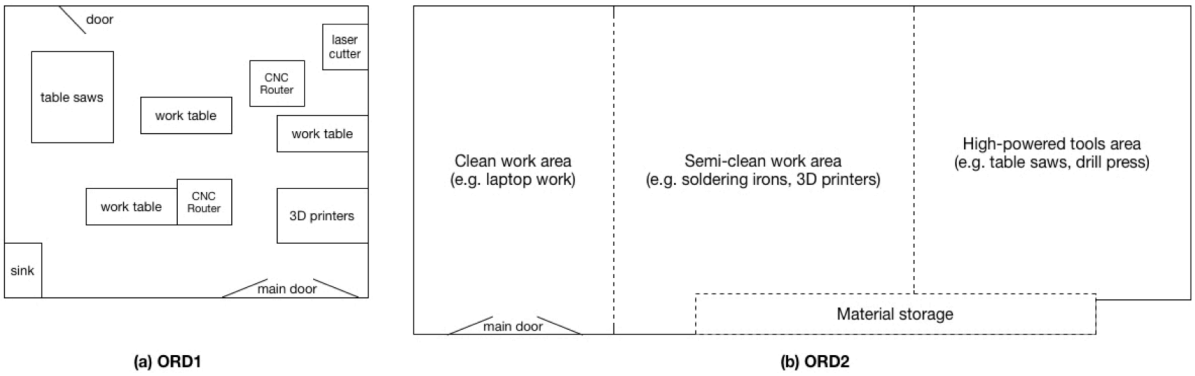

Figure 1: (a) ORD1 had high-powered machine tools placed throughout the workspace, which limited where peope felt comfortable performing non-building work needed for entrepreneurship (e.g. budget planning). Extra outside space not shown. (b) ORD2 is larger, has an open layout, and stages the work areas from less intimidating (clean laptop area) to more intimidating activities (high-powered tools). Extra storage space not shown. Images are relatively to scale.

Located relatively near the center of the city of Chicago, the location of ORD1, and hence ORD2, was chosen to be accessible by all areas of Chicago. Similar to ORD1, ORD2 is located at street level and is accessible by public transportation and car, and is located near a local city college with public bike rental options.

The ORD1 space (Figure 1a) had an open 4,300 sq. ft. layout, which allowed for modeling and informal coaching opportunities, but sometimes limited conversations and novice onboarding because the space was loud and unstructured. The new ORD2 layout (Figure 1b), which is 10,000 sq. ft. with a 15,000 sq. ft. storage area, has an updated open layout, designed in a way to better facilitate modeling, coaching, scaffolding, and exploration (Figure 1b).

Rather than having all tools spread out, ORD2's updated open layout is staged where the entrance is closest to the clean-work area and farthest from the high-powered tools. This allows novice members to work in a designated "safe" or "clean" area while watching a range of activity around them before deciding to move onto a potentially more challenging set of tasks. As the workshops from ORD1 demonstrated, novices liked learning complex tasks with

structured guidance and at their own pace. The ORD2 open, yet staged layout, combined with available workshops, builds on the cognitive apprenticeship concept of *scaffolding* where novices can work up to more challenging skills.

To further support entrepreneurship, ORD2 includes a designated photo and video production area, and will begin to offer workshops on a wider range of entrepreneurial skills, such as fundraising and financial planning. The existing social media channels of Facebook, Instagram, and Slack, are still used by members after ORD1 closed, and have been adopted for ORD2. This continued use of online communication tools highlights the value of social media in extending the benefits of community activity beyond the physical space.

3.5 Discussion

While HCI research on makerspaces has increased over the past five years, few have studied 1) entrepreneurially-focused makerspaces explicitly, and 2) how these makerspaces leverage socio-technical tools to promote community-focused values for entrepreneurial skill development. I study how novice entrepreneurs leverage the openness of a shared space, access to social technologies, and community of social support to develop entrepreneurial skills. This work shows that apprenticeship in co-located informal entrepreneurial communities relies on supporting distributed forms of communication.

Consistent with research on creative work environments (Amabile, Conti, Coon, Lazenby, & Herron, 1996), active distributed communication relies on community backbone of social support. Expectations of transparency and social support were embodied in both the open layout space and frequent use of community social technologies. The physical space provided

greater opportunities to observe others working, a key aspect of learning via cognitive apprenticeship (Collins, 2006), and to develop personal relationships for public validation, a key aspect of self-efficacy development (Bandura, 2001).

Social technologies played an important role in facilitating relationship and trust development. Being able to frequently interact both offline and online with peers and experts in a makerspace creates greater opportunity to develop entrepreneurial skills in a transparent and supportive environment. Consistent with literature on trust development online (Toma, 2010), frequent interactions online and in person helped members feel more comfortable reaching out to others even though they had never met before.

Our findings not only apply to makerspaces, but co-located informal workplace communities in general. Co-located communities are no longer limited by their physical space. Rather, I find that leveraging social technologies extends community interactions by providing a place to view others work and develop relationships with people who may not me in the space at the same time. By understanding how makerspaces support entrepreneurial skill development, we can further expand makerspaces as sites of career empowerment through entrepreneurship.

4. APPRENTICESHIP IN A DISTRIBUTED INFORMAL ENTREPRENEURIAL COMMUNITY

4.1 Introduction

Understanding new pathways to skill development in the future of work has become a key goal in human-computer interaction (HCI) as today's jobs are more likely to require lifelong training with limited dedicated expert guidance (Pew Research Center, 2016). I contribute to the growing literature on how people are leveraging the affordances of social technologies to construct apprenticeship-like instruction for professional work in the absence of dedicated guidance. For instance, researchers have described how amateur self-taught product and web designers seek inspiration and feedback through online creative communities (Hui, Gerber, & Dow, 2014; Marlow & Dabbish, 2014; Xu, Huang, & Bailey, 2014); how crowd workers communicate with peers in online forums to navigate workplace tools and carry out tasks (Gray et al., 2016); and how novice entrepreneurs coordinate with peers and supporters through crowdsourcing tools to perform publicity and manufacturing (Hui, Greenberg, et al., 2014). While previous work describes behavior specific to certain platforms, HCI literature lacks a sufficient conceptual understanding of what overarching instructional methods are shared amongst these distributed communities and how social expectations are shaping opportunities for skill development.

I answer the call by HCI researchers to apply learning sciences theories to better understand skill development in distributed communities (Williams, Kizilcec, Russell, & Klemmer, 2014; Williams, Renkl, Koedinger, & Stamper, 2013). Building on traditional theories of apprenticeship (Collins, 2006; Collins et al., 1991; Lave & Wenger, 1991), I introduce an emergent theory of *distributed apprenticeship* to uncover how community expectations of

transparency and social support, combined with the growing affordances of social technologies, are fostering opportunities for apprentice-like instruction in informal workplace communities. Specifically, I observe how distributed interactions in these communities are simulating methods of dedicated instructional guidance, which I define as being able to provide pedagogical *and* domain expertise to novices (Shulman, 1986).

Until now, apprenticeship in HCI has primarily been studied in offline learning communities, intelligent tutoring systems, and one-to-one mentorship relationships (J. D. Bransford, 1997; Collins & Brown, 1988; Collins, Brown, & Newman, 1989; Rosner, 2012; Su Yin, Haddawy, Suebnukarn, & Rhienmora, 2016; Suzuki, Salehi, Lam, Marroquin, & Bernstein, 2016). In these contexts, learning is directed by a dedicated instructor or central tutor, and target learning tasks are often clearly defined (e.g. solving a textbook math problem) (Collins, 2006; Suzuki et al., 2016). Our study broadens our understanding of apprenticeship in HCI to online informal workplace communities where there are hundreds or thousands of members performing different types of work tasks with and little to no formal guidance. I explore *how* people seek out apprentice-like experiences in the growing landscape of social technologies. In doing so, I identify benefits and challenges for professional skill development in the modern digital age.

Crowdfunding—the online request for resources from a distributed supporters often in exchange for a reward (Belleflamme, Lambert, & Schwienbacher, 2013; Gerber & Hui, 2013) – is an ideal context to study entrepreneurial skill development in distributed workplace communities. Unlike previously described vignettes of social learning in professional settings (Wenger, 1999), crowdfunding entrepreneurs are geographically distributed, are expected to learn how to perform complex tasks with little guidance or training, must build and maintain

relationships with hundreds of thousands of supporters around the world, and must search through and make sense of online examples of peer work in order to inform their own campaigns. Without the help of dedicated expert instruction, many novice crowdfunders face difficulties developing the skills to perform tasks in this novel workplace environment (Hui, Gerber, & Gergle, 2014; Hui, Greenberg, et al., 2014).

Our driving research question is, ***How do the socio-technical affordances of distributed informal entrepreneurial communities support apprenticeship in the absence of dedicated expert instructors?*** To answer our research question, I conducted semi-structured interviews with 62 crowdfunding entrepreneurs (from now on referred to as "crowdfunders"). I contribute to the field of HCI by proposing an emergent theory of *distributed apprenticeship*, which describes how the socio-technical affordances of distributed workplace communities allow novices to seek and combine instruction from distributed sources to simulate the benefits of apprenticeship. By studying how novices in distributed workplace communities acquire skills through online interactions, we can inform the design of social technologies to better support scalable opportunities for instruction.

4.2 Background on Crowdfunding

Crowdfunding–the online request for resources from a distributed audience often in exchange for a reward [16]—has emerged as the most recent Internet based technology to support community in entrepreneurship. Since the first crowdfunding platform launched in 2001 (Knowledge @ Wharton, 2010), there are now an estimated over 1,250 crowdfunding platforms across the world (Drake, 2016). Crowdfunding platforms have raised project donations ranging from a couple

dollars to over $20 million dollars ("Kickstarter Stats," 2016), for an estimated total of $17.5 billion, setting new funding records almost every year and soon to surpass venture capital funding (Massolution, 2015). Our study focuses on reward-based crowdfunding platforms—funding in exchange for a reward for creative projects—as they have historically appealed to novice entrepreneurs for supporting the launch of new products and services (Hui, Greenberg, et al., 2014). Reward-based crowdfunding platforms can include project categories of art, comics, craft, dance, design, film, fashion, food, games, music, photography, publishing, theater, and technology.

Researchers across different domains, including human-computer interaction, entrepreneurship, management, and economics have primarily studied what factors affect crowdfunding success, such as project description wording (Mitra & Gilbert, 2014), updates (Xu, Yang, et al., 2014), donor coordination (Solomon, Ma, & Wash, 2015; Wash & Solomon, 2014), and role of communities in the enterprise (Muller, Geyer, Soule, Daniels, & Cheng, 2013; Muller, Geyer, Soule, & Wafer, 2014) and non-enterprise contexts (Hui, Greenberg, et al., 2014). For instance, using certain campaign language (Mitra & Gilbert, 2014) and having greater social capital online is correlated with greater crowdfunding success (Mollick, 2013). Studies on the timing of donations have found that early donations are crucial to increasing the likelihood of reaching one's funding goal (Agrawal, Catalini, & Goldfarb, 2013; Ordanini, Miceli, Pizzetti, & Parasuraman, 1995; Solomon et al., 2015; Wash & Solomon, 2014). However, simply knowing these strategies does not help entrepreneurs perform crowdfunding tasks successfully; participants must also have the knowledge and skills for implementation.

4.2.1 Early Work on the Crowdfunding Community

Despite the growing interest in understanding what factors lead to crowdfunding success, there is little work describing *how* people perform crowdfunding work. This is particularly troublesome considering that many crowdfunders are novices who have never launched an entrepreneurial endeavor before. Novice entrepreneurs are in the greatest need of advice and other forms of support (Collinson & Gregson, 2003; Davidsson & Honig, 2003; Hoang & Antoncic, 2003), and are the least likely to have access to adequate resources and training (Audet & St-Jean, 2007; R. Bennett, 2008; R. J. Bennett & Robson, 1999). Furthermore, unlike the more common methods of studying crowdfunding behavior, such as through collecting online platform data (Ahlers,

Crowdfunding Work	Definition	Role of Community	Examples of Technologies Used
Prepare	Prepare campaign materials	- Provide example projects as models - Provide general advice blogs - Give one-on-one advice - Offer specialized skill expertise	- Crowdfunding platform search - Third party project search platforms (e.g. Kicktraq) - Blogs
Test	Test campaign materials	- Give feedback on campaign materials - Provide opinion on design direction	- Email - Crowdfunding campaign page - Social networking platforms (e.g. Facebook, Twitter) - Pre-campaign project platforms (e.g. Prefundia)
Network	Market the project by using campaign materials	- Spread the word - Build an audience	- Social networking platforms (e.g. Facebook, Twitter) - Online forums (e.g. Reddit)
Follow Through	Follow through with project goals and send rewards	- Provide manufacturing or shipping support - Offer specialized skill expertise	- Online skill marketplaces (e.g. Upwork) - Manufacturing support platforms (e.g. Backerkit, Fullfillrite, Teelaunch)
Reciprocate	Reciprocate resources back to the crowdfunding community	- Provide advice - Provide financial resources	- Blogs - Personal webpages - Email - Crowdfunding platform donations

Table 2: Table of crowdfunding work, including definitions, role of community, and types of technologies used throughout the work process. Types of crowdfunding work are not necessarily performed sequentially and can occur at the same time (Hui, Greenberg, et al., 2014).

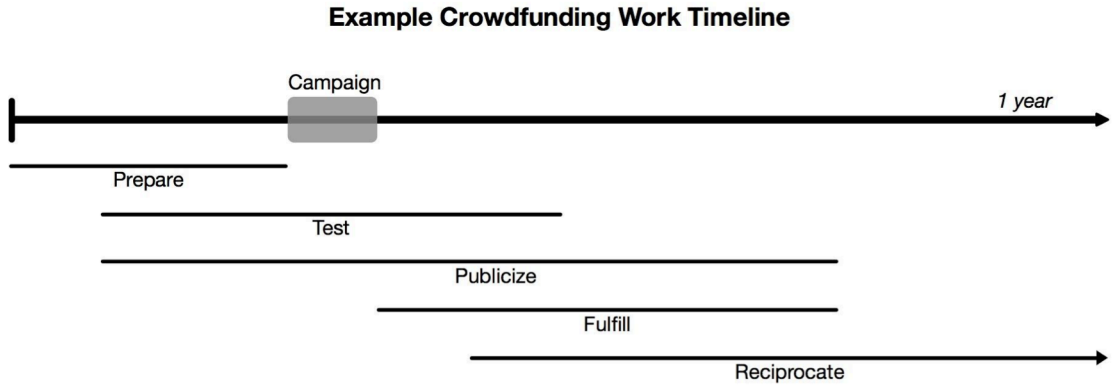

Figure 2: Typical crowdfunding work process, which shows how the campaign is only one small part in the list of crowdfunding responsibilities.

Cumming, Günther, & Schweizer, 2015; Colombo, Franzoni, & Rossi-Lamastra, 2015; Mollick, 2013) and experiments (Solomon et al., 2015; Wash & Solomon, 2014), few have taken a qualitative approach to understand the day-to-day experiences of crowdfunding. Our in-depth qualitative approach through interviews allows us to develop a rich understanding of how crowdfunding entrepreneurs coordinate and leverage their community.

I found that crowdfunding entrepreneurs leverage their crowdfunding communities to perform crowdfunding work (Hui, Greenberg, et al., 2014) and build entrepreneurial self-efficacy (Harburg, Hui, Greenberg, & Gerber, 2015) to develop entrepreneurial careers. I define the crowdfunding community as anyone performing crowdfunding work (novices and peers), people who invest in or benefit from crowdfunding work (supporters), and people who support the process of crowdfunding by sharing relevant skills (domain experts).

Crowdfunding entrepreneurs leverage their community to carry out five main types of work— *preparing* the campaign material, *testing* the material, *publicizing* the project, *following through* with project goals, and *reciprocating* resources to the community (Hui, Greenberg, et al., 2014) (See Table 2). These tasks are not performed linearly and distinct from one another, but often

happen at the same time with requesters iterating on certain tasks over the course of the their crowdfunding experience (e.g. Figure 2).

These findings suggest the community aspect of crowdfunding work, including publicizing to the general Internet audience and managing hundreds or thousands of supporters, introduces unique difficulties to the typical entrepreneurial process. Over the last decade, crowdfunding has become increasingly professionalized, raising the expectations for participation. A host of new services are rising up to support the proliferation of crowdfunding activity. Professionals are now paid to create pitch videos, manage communications, and distribution, which novices are often not able to employ given limited capital. As the bar for performance inches higher and higher, would be entrepreneurs who are unable to perform at this level or have funds to hire professionals may be crowded out.

Continued lack of diversity and rising barriers to entry challenge one of the initial promises of crowdfunding, which was access to resources to novice entrepreneurs who lack connections. I seek to understand how novice entrepreneurs leverage social technologies in crowdfunding communities to acquire the skills needed to overcome the increasingly challenging nature of crowdfunding work. To do so, I draw from related work on in learning sciences on apprenticeship and co-regulated learning.

4.3 Methods

4.3.1 Sample and Procedure

I interviewed 62 crowdfunding project creators from the crowdfunding platforms, Kickstarter and IndieGoGo—two of the most popular reward-based crowdfunding platforms in the US

(Alexa.com, n.d.). Project types, as defined by the crowdfunding platforms, included art (2), comics (2), dance (1), design (7), education (5), fashion (2), film & video (6), food (4), games (5), music (3), photography (5), publishing (7), radio & podcast (1), science (1), technology (9), and theater (4). Participants (26% female) raised between $41 and $433,365 in 1 to 3 months, and include 41 first time project creators and 21 creators who launched more than one campaign. The majority of participants described having a full-time job or freelance position outside of crowdfunding. Participants' ages ranged from 20-65. It is difficult to know what is a representative sample based on demographics because the crowdfunding platforms that I studied do not make racial and gender demographic data publicly available.

I recruited participants through a random seed with snowball sampling (Miles & Huberman, 1994), which allowed us to identify participants from a wide range of project categories, who had both large and small funding goals, and who succeeded and failed. While random sampling would have produced a more representative sample, limits on using the crowdfunding platform messaging systems prevented this approach. I then followed a semi-structured interview protocol where I asked the participants how and why they decided to crowdfund, and how they learned to perform different crowdfunding tasks. Interview length ranged from 30 minutes to 1 hour, and took place in person, over the phone, and through video call. Interviews were conducted both during and after the crowdfunding campaign, which allowed us to collect both reflective and in situ data. Four researchers performed data collection, but one researcher ran or co-ran 85% of the interviews. Data collection occurred from 2011-2015. Interviews allowed us to gather in-depth data on the experiences of multiple people

performing crowdfunding work not easily accessible through other methods such as observation or surveys.

In addition to performing interviews, I also actively participated in the crowdfunding community by following recently launched projects, donating to multiple projects, running our own campaign, and following platform updates through regular platform observation and posted news and social media updates. This allowed us to observe how the platform practices and design changed over time.

4.3.2 Analysis

Following interview transcriptions, I analyzed data using pre-structured case analysis (Miles & Huberman, 1994). This involved choosing categories in the coding scheme based on the existing theories of apprenticeship (Collins, 2006; Collins et al., 1991) and then adding nuance by amending and developing categories as I analyzed data. The focus on apprenticeship and co-regulated learning emerged, as well as other themes such as collaboration, networking, and motivation, during a previous ongoing longitudinal grounded theory study of crowdfunding. Analysis occurred during and after data collection, which allowed us to amend our interview protocol to better capture data related to skill acquisition.

Our first round of codes was based on the six instructional methods of cognitive apprenticeship: modeling, coaching, scaffolding, articulation, and reflection (which includes traditional apprenticeship methods of modeling, coaching, and scaffolding). Two researchers read through interviews and collected instances of these methods in a spreadsheet. For inter-rater

reliability, two researchers coded 15% of the data (κ=0.81). After this initial check, one researcher coded the remainder of the data.

I then performed a second round of coding to identify how data initially coded into apprenticeship methods were similar or different from the traditional definitions. This allowed us to identify how the context of crowdfunding influenced the instantiation of apprenticeship in a new way. In doing so, I did not change our view of crowdfunding so that it would fit within existing apprenticeship frameworks, but rather provided an amended view of how apprenticeship is instantiated in the social context of an informal workplace community. For instance, examples of people looking at other crowdfunding campaigns for inspiration were initially coded under modeling, which describes novices observing others' work to inform their own. While looking at other crowdfunding campaigns is an example of traditional apprenticeship because it highlighted the visual aspect of modeling, it led us to question how novices were experiencing the cognitive aspects of modeling. Taking an analytical lens through both traditional and cognitive apprenticeship allowed us to identify how participants consulting related posted peer material, such as through blog posts and videos, provided an avenue to observe cognitive aspects of modeling lacking from many project campaign pages. These activities were then both coded under the final theme of *consulting examples of peer work*, in which I describe the nuances of how modeling is experienced in the online context of crowdfunding.

I also removed codes pertaining to skill development that did not rely on social interactions in the distributed workplace context. For example, a participant described working on a friend's project full-time before starting his own. While this might be considered an example of traditional apprenticeship, I excluded it from our final analyses because it did not

address our original research question to understand how social interactions through the online community influenced learning opportunities. Rather it provided a traditional example of apprenticeship where a novice works full-time alongside an expert to develop skills in-person. Other examples of excluded data included individual instances of trial-and-error, such as filming multiple versions of the campaign video without feedback from others in order to develop videography skills. While these instances of skill development are interesting, I felt that they distracted from the main goal of the study. I welcome future research to better understand these offline and individually-driven approaches to skill acquisition of complex work.

4.4 An Emergent Theory of Distributed Apprenticeship

While apprenticeship has been lauded as one of the most effective ways to develop skills, its existing theories do not describe how it can be best facilitated in informal workplace contexts, where work is learned on the job often with minimal support. Professional work outside traditional corporations increasingly relies on using social technologies to acquire skills and develop professional relationships. However, people working in informal contexts face challenges of developing skills where 1) there is often no dedicated instructor, 2) there are increased expectations of transparency and social support with a global network of peers and supporters, 3) there are thousands of examples of peer work to view and make sense of, and 4) the work is often more complex in that is non-routine, difficult to plan, and involves various sub-goals and diverse expertise. A new theoretical understanding of how people access apprentice-like instruction in online workplace communities is needed to advance how I design socio-

technical systems that can better support the growing population of people developing professional skills through online communities.

To inform theory development, I state key assumptions about the behavioral phenomenon being described, provide explicit definitions of key terms, outline principles that can be tested through research, and explain the underlying psychological dynamics that influence learning (Hull 1935, Gredler 2009). In the follow sections, I outline two basic assumptions of *distributed apprenticeship*: a) In order to scale apprentice-like opportunities in informal workplace communities, instruction must be directed by a distributed network of non-expert instructors, and b) Social expectations of transparency and mutual support in these communities are needed to drive this distributed nature of instruction. I go on to define the explicit variables of distributed apprenticeship, outlining principles as observed in the context of crowdfunding, and provide data describing the cognitive mechanisms that encourage learning via online social interactions.

4.1.1 Attributes of Distributed Apprenticeship

Through a study of how people perform skill development activity in the online workplace community of crowdfunding, I identify six attributes of distributed apprenticeship: non-expert instructors, distributed instructional network, workplace context, instructional methods (consulting examples of peer work, seeking feedback from extended networks, explaining work processes to maintain reputation, and sharing work reflection for community wellbeing), ill-structured work tasks, and the ability to scale. I briefly describe how distributed apprenticeship is unique from traditional and cognitive apprenticeship in Table 3, followed by in-depth descriptions of each attribute.

Attributes	Definition	Traditional Apprenticeship	Cognitive Apprenticeship	Distributed Apprenticeship
Instructional Directors	People who initiate instructional activity	Expert-directed	Expert-directed	Non-expert directed
Instructional Network	Distribution of people involved in supporting instruction	Centralized	Centralized	Distributed
Instructional Context	Context in which instruction occurs	Workplace (mainly offline)	Pedagogical	Workplace (mainly online)
Instructional Methods	Methods to support learning	- Modeling - Scaffolding - Coaching	- Modeling - Scaffolding - Coaching - Articulation - Reflection - Exploration	- Consult posted examples of peer work (like modeling) - Seek feedback from extended networks (like coaching) - Explain work process to maintain relationships (like articulation) - Share work reflection for community wellbeing (like reflection)
Task Complexity	Complexity of tasks typically learned	Semi-complex	Semi-complex	Complex
Scalability	The extent to which the instruction is scalable beyond small teacher-to-student ratio	Not scalable (~4) (e.g. small group)	Minimally scalable (~4E+1) (e.g. size of a large classroom)	Scalable (~4E+3) (e.g. average number of crowdfunders running campaigns at one time)

Table 3. The attributes of distributed apprenticeship in comparison to those of traditional apprenticeship and cognitive apprenticeship.

Instructional Directors

Instructional directors are people who initiate instructional activity, such as identifying the need for coaching or encouraging articulation. Unlike in traditional and cognitive apprenticeship, instructional directors in distributed apprenticeship are ***non-expert instructors***, meaning they are not necessarily trained as instructors or intentionally perform instruction to support novices. Non-expert instructors might include people who have similar work goals (peers), people who are interested or benefit from one's work (supporters), and people who have skills relevant to performing one's work (domain experts). At most, domain experts might possess instructional expertise, but it is not assumed. As Lee Schulman states in his seminal work on pedagogical content experts, "Mere content knowledge is likely to be as useless pedagogically as content-free

skill" (Shulman, 1986). I describe how novices in online workplace communities benefit from the community expectations of transparency and social support in order to experience instructional guidance from distributed community members.

Instructional Network

Instructional network is the distribution of people involved in supporting instruction, such as the instructional directors and those who provide instructional material, like feedback. The instructional network in distributed apprenticeship is a ***distributed instructional network***, which means novices develop skills by seeking and combining instruction from diverse community sources using different social technologies. Unlike traditional and cognitive apprenticeship, where a single or small group of instructors guides the novice through the entire problem solving process, instructors in online workplace communities are transient. For instance, a novice might leverage interactions with peers to gather feedback and interactions with domain experts to seek advice. Similar to the theory of distributed cognition, where cognitive processes are distributed in a social group (Hollan, Hutchins, & Kirsh, 2000), I describe distributed apprenticeship as the process by which instructional processes are distributed in online communities. While this approach to instruction allows novices to piece together knowledge in order to perform a diversity of tasks, novices are often burdened with the additional responsibility of identifying, connecting with, and motivating distributed community members to perform instruction.

Instructional Context

Instructional Context is the context in which novices develop skills. In distributed apprenticeship, instruction takes place in an ***informal workplace context***, which means that

novices develop skills on-the-job with minimal guidance from an instructor in a formal organization. Workers may share broad professional goals with their community (e.g. crowdfunding), but work on individually different projects (e.g. startup on food vs. fashion). Novices are more likely to be motivated to learn in this context because skills are directly applicable, allowing them to easily see how the skills are relevant and applicable to their work (Collins et al., 1991). This is different from cognitive apprenticeship where novices develop generalizable skills (e.g. algebra) in a pedagogical context, like a classroom, and then apply their knowledge to workplace contexts later on in an "exploratory" stage (Collins, 2006). While informal workplace contexts provide the benefits of directly applying knowledge, it limits opportunities to practice skills in a low-risk environment.

Instructional Methods

Instructional methods are methods applied by instructional directors to support learning. Distributed apprenticeship includes four instructional methods inspired by traditional and cognitive apprenticeship (Collins, 2006): 1) ***Consulting posted examples of peer work*** is similar to traditional modeling and refers to novices observing multiple examples of others' work to inform how to perform one's own, 2) ***Seeking feedback from extended networks*** is similar to traditional coaching and refers to novices identifying and seeking advice and feedback about their work from various community members, 3) ***Explaining work processes to maintain relationships*** is similar to articulation and refers to novices explaining their planning and problem solving process to community members invested in the work, 4) ***Sharing work***

reflection for community wellbeing is similar to reflection and refers to novices describing their performance and identifying opportunities for improvement in order to support others work.

Task Complexity

Task Complexity refers to the complexity of skills needed to perform in one's workplace environment. In distributed apprenticeship, novices must develop skills to perform ***complex work***—work that is non-routine, difficult to plan, takes a certain level of expertise, requires specific resources, involves different types of workers and coordination, and includes various project goals (Strauss, 1988). Complex work has also been referred to as ill-structured problems (Simon, 1973) and wicked problems (Buchanan, 1992; Rittel & Webber, 1973). To say that work described in traditional apprenticeship (e.g. shoemaking, farming) and cognitive apprenticeship (e.g. math, reading) is not complex would be misleading as it takes a certain level of cognition to perform these tasks well. However, I focus on work that does not necessarily have a "right answer," as with classroom math problems, or pre-set performance pathways, as with professions traditionally studied for apprenticeship, like shoemaking. Rather, the work that I study is more reflective of the increasingly complex responsibilities of modern-day professions where skills have a limited lifetime of a few months to a few years and perpetual skill development is a required for continued employment (Pew Research Center, 2016).

Scalability

Scalability refers to the extent to which instruction is scalable beyond a small teacher-to-instructor ratio. In distributed apprenticeship, instruction is more ***scalable*** because the socio-technical affordances of the online community can accommodate a growing community of

learners. Unlike literature on classroom technologies, which describes how teachers scale instruction by shifting responsibility to tools (Bain, 2012), our framework of distributed apprenticeship expands this work to describe how social technologies can scale instruction by distributing instructional responsibilities among different members of an online community. While Collins (1991) developed cognitive apprenticeship as a way to scale apprentice-style instruction to classroom sizes of at most a couple dozen students (Collins et al., 1989), I expand this work to describe how social technologies can help to further scale apprentice-like instruction to communities of hundreds or thousand of members.

I believe this description of the attributes of distributed apprenticeship provides a useful framework by which to view and understand skill development in online workplace communities where there is no dedicated expert instructor. In the following section, I describe how the instructional methods of distributed apprenticeship were developed through a qualitative study of the online crowdfunding community.

4.5 Distributed Apprenticeship in Crowdfunding

The data highlights how crowdfunding entrepreneurs leverage social technologies to identify and combine apprentice-like instruction from different community members across platforms. This is the first study to develop a theoretical understanding of how skills are being developed in informal workplace communities through the lens of apprenticeship. Apprenticeship is one of the most effective approaches to professional skill development. But, little work has been done to effectively adapt apprenticeship instructional methods to modern work practices where people

leverage multiple online platforms to acquire resources, develop relationships, and seek knowledge. Through our qualitative analysis of online behavior in crowdfunding communities, I uncover four main instructional methods of distributed apprenticeship (see Table 4).

Similar to prior theories of apprenticeship, I offer a description of how participants participate in activity typically shown to provide learning gains, rather than evidence of explicit learning gains (Collins, 2006). While each section describes an instructional method of distributed apprenticeship, the methods are not always mutually exclusive as one method could trigger or overlap with another.

4.5.1 Consult Posted Examples of Peer Work

One of the most common ways novice crowdfunders described developing skills was by consulting work examples posted by peers. Traditionally, modeling involves a pedagogical domain expert intentionally performing a task, so that a novice can learn to emulate their actions (Collins, 2006). However, in crowdfunding, there is no single or small group of designated instructors who model the entire process of crowdfunding because only portions of their work are displayed publicly online. Rather, novice crowdfunders must search for and combine example work posted on multiple platforms by a ***distributed network*** of ***non-expert instructors***, such as crowdfunding ***peers***. The plethora of crowdfunding projects online provides the opportunity to ***scale modeling*** because novice crowdfunders are able to access a repository of examples from which to take inspiration. Having access to relevant work models is particularly useful for developing skills in a ***workplace context***, like crowdfunding, where novices must develop and apply skills within weeks or days.

Participants described searching through campaign material on crowdfunding platforms and related social media platforms, watching videos, and reading through reward ideas and project descriptions to identify which crowdfunding practices to emulate. For example, one novice crowdfunder raising funds to launch a food truck venture described how he contrasted the language of successful and unsuccessful campaigns to identify what tone to use when publicizing his project:

> *"It was very clear to see on the failed versus projects that didn't fail, there was almost like an arrogance for the ones that failed, 'I'm so great. I'm so wonderful. You've got to give me money!' And they failed miserably. And the ones with a little more humility and a little more earnestness seemed to be more successful." (P23)*

Similarly, other participants described looking through existing campaigns on crowdfunding platforms to *"figure what was common to the successful ones and common to the failed ones"* (P49). In the case of crowdfunding, project "success" (meeting the campaign funding goal) is easy to determine because it is publicly displayed on the campaign page, which indicates to novices what projects may serve as better work examples.

While crowdfunding platforms have made it easier to find projects in a certain category with a particular funding goal or amount pledged, they still make it difficult to find failed projects. In response, members of the crowdfunding community have created third party platforms that facilitated searching for unsuccessful campaigns so that crowdfunding entrepreneurs could learn from them. However, in the past years many of these third party platforms were pressured to shut down by crowdfunding platforms for unknown reasons (KickSpy, n.d.). Since then, crowdfunding platforms, like Kickstarter have advanced their

	Instructional Methods of Distributed Apprenticeship			
Attribute	**Consult posted examples of peer work**	**Seek feedback from extended networks**	**Explain process to maintain relationships**	**Share reflection to support community wellbeing**
Definition	Looking at other people's campaign material and related media posts across platforms for inspiration or advice.	Seeking and/or receiving feedback and advice on one's campaign material, process, or final product.	Explaining one's campaign process or final product in campaign material, social media, or Q&A.	Sharing one's overall experience, lessons learned, and plans for the future.
Instructional Directors *(Non-expert instructors)*	-*Novice* searches for and consults examples of peer work	-*Novice* identifies and seeks feedback from domain experts, peers, and supporters	-*Supporters* requests work updates and Q&A from novices	- *Peers* solicit advice from (former) novices - *Supporters* request work overview
Instructional Network *(Distributed)*	-*Peers* (e.g. Other crowdfunders)	-*Peers* (e.g. Other crowdfunders) -*Domain experts* (e.g. Professional videographers, marketers) -*Supporters* (e.g. People who financially/socially invested in work)	- *Supporters* (e.g. People who financially/socially invested in work)	-*Peers* (e.g. Other crowdfunders) - *Supporters* (e.g. People who financially/socially invested in work)
Instructional Context *(Workplace)*	-Example models created for work, not instructional, purposes -Example reflections posted by peers, not instructional experts	-Feedback sought from member of workplace community (domain experts, peers, supporters), rather than dedicated instructor	- Supporters request work updates and Q&A for their own benefit, not to facilitate instruction	- Peers and supporters request project reflection to support their own needs, not to perform instruction
Task Complexity *(Complex)*	- e.g. How to structure materials unique to one's work	- e.g. How to plan work - e.g. How to manage team - e.g. How to manage supporter relationships	- e.g. How to plan work - e.g. How to overcome unexpected challenges	- e.g. How to evaluate one's performance - e.g. How to plan for future work
Scalability *(Scalable)*	More examples of peer work created as more people create projects	More and diverse set domain experts, peers, and supporters available as more people create projects	Supporters intrinsically motivated to request updates and Q&A because they are invested in novice work	More reflections requested as crowdfunding community grows
Challenges	- Finding examples that share process and cognition - Finding examples created by similar others - Sensemaking of examples	- Identifying feedback providers - Motivating responses from feedback providers - Facilitating useful feedback from providers - Encouraging timely feedback from providers	- Facilitating mutually beneficial relationships where supporters benefit from explanations and novices benefit from articulating - Supporting process documentation at all project stages	- Facilitating mutually beneficial relationships where peers/supporters benefit from consuming reflections and novices benefit from reflecting - Managing advice and feedback requests - Efficiently distributing advice and feedback requests among crowdfunders
Relation to cognitive apprenticeship	modeling	coaching	articulation	reflection
Relation to traditional apprenticeship	modeling	coaching	N/A	N/A

Table 4. Instructional methods of distributed apprenticeship as described through the context of crowdfunding. Unlike traditional and cognitive apprenticeship, distributed apprenticeship is performed by a distributed network of non-expert instructors.

project search features, highlighting how members of crowdfunding communities influence the development of and competition for formal crowdfunding platforms, an example of user innovation (von Hippel, 1988, 2005).

Having access to a repository of examples through crowdfunding platforms provides a way to ***scale*** modeling in ***workplace contexts*** where people work on different projects, with unique goals and challenges. Because crowdfunding platforms allow searching of projects by certain attributes (e.g. category, funding amount), novice crowdfunders can find models that are similar to their own campaign. For instance, one crowdfunder of a product design project to manufacture a new type of wall hook described how he searched for projects similar to his in order to inform his own campaign format:

> *"Before I launched my Kickstarter I spent quite a few days going through other projects, looking at their videos, how they structured their rewards and learned a lot from that, and figured out what was important for Kickstarter. I had a lot of projects in the similar bracket and picked things I liked from them and then figured out what I wanted to do." (P50)*

Already, there are over 350,000 launched projects on Kickstarter, the most popular crowdfunding platform in the United States, and one of over 1,250 platforms in the world (Drake, 2016; "Kickstarter Stats," 2016). As more people continue to crowdfund, new examples get added to the repository of example work that can serve as models for future novice crowdfunders.

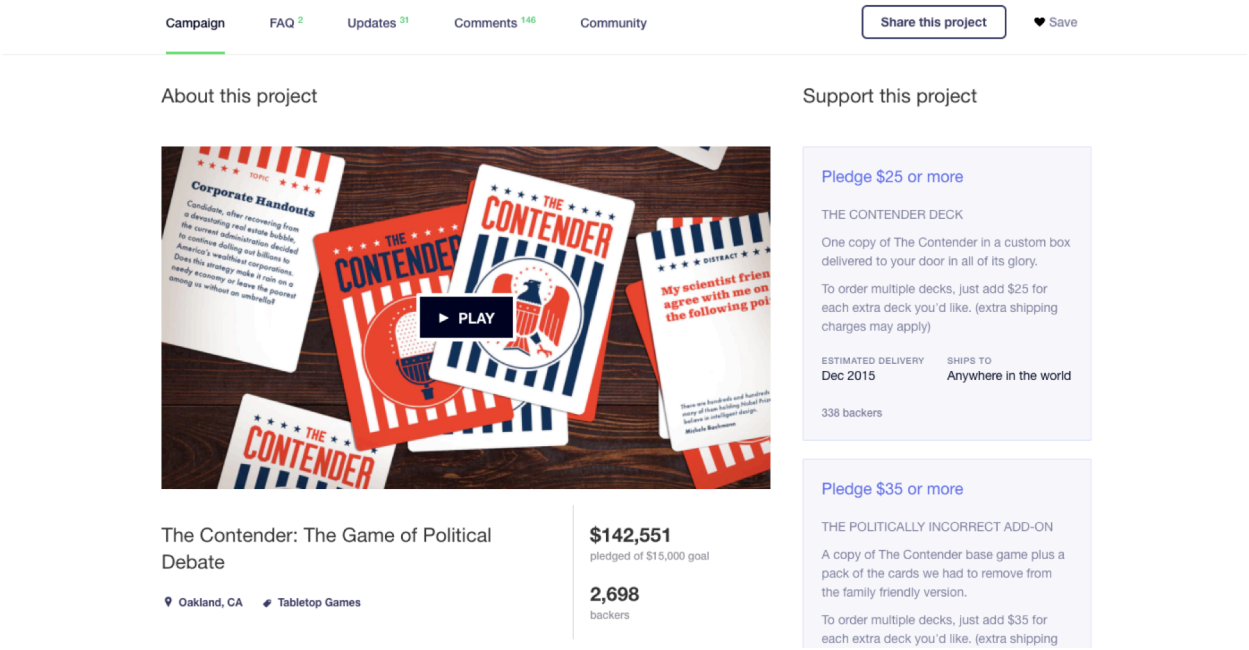

Figure 3. Example of a Kickstarter campaign page, which includes a video, description of rewards, funding goal, updates, and comments section (The Contender, n.d.). Publicly available campaigns serve as instructional material by acting as models of what high or low quality campaigns might look like.

While seeing examples of finished crowdfunding campaigns (e.g. Figure 3) provides a useful outline for what one's finished work should look like, these examples can be lacking because it is harder to understand the reasoning behind other project creators' decisions. Unlike modeling in cognitive apprenticeship where an instructor performs a task in front of a novice while articulating their reasoning, most online examples of crowdfunding are just of the end product (e.g. final campaign video) rather than the entire production process with the reasoning behind it (e.g. how video was planned and filmed), which limits the extent to which novices can learn from examples of others' work.

One way that crowdfunders understand other's reasoning behind a choice is by reading social media updates and blog posts in which crowdfunders have articulated their reasoning. One-third of participants described reading blogs posted by other crowdfunding entrepreneurs to

learn more about crowdfunding responsibilities. While some posts just provide a narrative description of how they felt during their crowdfunding experience, others go as far as structuring each step, providing reasoning, and performing statistical analyses to show which strategies produced the highest funding contributions (Mod, 2010). For instance, one participant raising funds to develop a new art-based education program described reviewing other's crowdfunding blog posts to help him set his publicity strategy.

> *"I just did searches for, you know, Kickstarter projects and I found examples where people had written in their blog about their own projects and how they had organized their approach. So some people were very scientific about saying, okay, I'm going to you know contact X number of blogs, I'm going to send so many thousand emails and I'm going to do it in this specific order for a particular reason. And then they graphed how many responses they would get and had a plan...I tried to read what some of what [they] had done and pay attention to the ones of people who were successful and tried to learn from them." (P4)*

In this case, P4 describes how reading these blog posts allowed him to understand an expert's process and *why* they performed a task *"for a particular reason,"* highlighting how these posts illuminate some of the invisible cognitive processes behind structuring and running a campaign. Previous work I have done on crowdfunding communities uncover a shared feeling of responsibility to "give back" to the community and support novice members (cite omitted), a motivation perhaps extended from related creative communities, such as hackerspaces (Toombs et al., 2015).

In another example, a project creator who ran a successful campaign to fund a political card game wrote an update on their campaign page, saying *"In the spirit of giving back, we*

wanted to share what we learned on the Kickstarter campaign trail. We put everything in a Medium post you can find below" (The Contender, 2015). In this post, they describe why and how they made certain decisions regarding their campaign, such as how they structured their rewards:

> *"In the interest of keeping cost down and maximizing our resources we refrained from many physical perks beyond the highest donor levels. Why? Because physical products need to be customized by order and possibly create more expensive shipping. THINK OF THIS STUFF AS EARLY AS POSSIBLE."*

Supplemental posts on social media and crowdfunding platforms provide an additional place for experienced crowdfunders to explain reasoning that is not immediately visible by just looking at the campaign page. A novice crowdfunder looking at a campaign page for ideas might notice that there are not many physical rewards, such as t-shirts or hand-made thank you cards. But, without reading the supplemental posts, they would not know the reason why and therefore be at risk of making mistakes with their own campaign, such as choosing promising rewards that are difficult make or ship.

While supplemental posts allow project creators to articulate cognition behind their work, people might often forget certain parts of their process or describe their actions in a different way than how they were performed—a fundamental problem in instruction (Shulman, 1986). This is an especially difficult issue to address in communities like crowdfunding, where instruction is not always intentional and the people providing instruction are typically ***non-expert instructors***.

Advances in communication technologies are providing easier ways for crowdfunders to communicate in-the-moment thought processes with their supporters. For instance, in November

2016, Kickstarter launched a live video feature called Kickstarter Live in which they encourage crowdfunders to "connect with their community in new ways," such as "[sharing] early designs and [demoing] prototypes" or "[hosting] a Q&A with everyone involved in the project." Crowdfunders have also been using similar features on other social media platforms, like Snapchat and Instagram Live to communicate with their supporters as they work.

In order to acquire observable and cognitive skills, novice crowdfunders leverage modeling to study both visual examples of finished products, such as the main campaign page, and related social media posts where peers articulate cognition behind their process. While online search features help novice crowdfunders to identify relevant examples, novices still need to be able to make sense of these models with limited instructional guidance.

4.5.2 Seek Direct Feedback from Extended Networks

Seeking feedback and advice from an extended network of domain experts, peers, and supporters provides a way to receive a wider range of instruction through ***coaching***. Unlike traditional coaching, where pedagogical domain experts direct instruction by observing learners and providing advice and feedback as needed (Collins, 2006; Hattie & Timperley, 2007), coaching in distributed apprenticeship is directed by the novice, who must often self-identify when and from whom to seek support. Like many ***workplace contexts***, where novices are in charge of their own skill development (Yarosh, Matthews, Zhou, & Ehrlich, 2013), novice crowdfunders must self-direct coaching opportunities by identifying or motivating advice and feedback from a ***distributed network*** of ***domain experts***, ***peers***, and ***supporters***.

Participants described establishing relationships with ***domain experts***, people who have expertise in an aspect of crowdfunding work (e.g. marketing) but are not crowdfunders themselves, through existing offline and online connections. For example, two participants in graduate school who launched a campaign to manufacture an electronics kit described being advised by an online media professor:

> *"We had several email exchanges. We sent her drafts of our video, and had 2 or 3 face-to-face meetings…She gave us a lot of constructive criticism like, 'Ok, you're getting better but here's some more things to think about.' She gave us tips on how to compose videos, which none of us have done before, so that was really helpful. She gave us like lighting diagrams, so like if you want to light someone well, here's where you put the lights. If you want to record good audio, here's what you need to buy." (P54)*

They exceeded their $25,000 goal by raising over $121,000 in 30 days. Participants who had access to long-term expert support were typically enmeshed in a rich knowledge network, such as a school, incubator program, or online community specific to their project topic.

Other participants described connecting with domain experts through online forums or listservs in their project domain. When developing a new board game for a crowdfunding campaign, P52 described asking questions on different active board game design forums, such as on Reddit, to *"get additional feedback"* on their campaign and ask product questions like, *"What do you think of this concept?"* Another participant (P5), who graduated from a prestigious design program, described how he emailed out to the alumni design listserv and received various feedback responses.

Figure 4. Example of someone seeking feedback for their beauty-related Kickstarter project through Reddit ("Reddit," n.d.). Posting requests for feedback on public online forums allows people to get advice and feedback from feedback outside one's immediate social circle.

Participants also leveraged search functionalities on crowdfunding platforms to identify ***peers*** (other crowdfunders) who had run similar crowdfunding campaigns. For instance, one crowdfunder running a campaign for a publishing project described how he searched for all the people who did a campaign similar to his and asked them for advice:

> *"I went and surveyed everybody who had done a Kickstarter project to fund digital fonts, which is like 12 people or something. And all but one of them was willing to give me feedback, and it was pretty interesting and useful." (P39)*

Similarly, one participant developing a food startup to support local beekeepers described how friends and supporters would connect her with others running similar campaigns.

> *"I'd get people who were like, you need to get in touch with so-and-so...I even got in touch with two girls up in Minneapolis who are doing something exactly the same. So I was on the phone with them...and that was just so much fun to get to connect with them." (P10)*

In addition to seeking work process feedback, novice crowdfunders described how the online public nature of crowdfunding helped them receive product feedback from ***supporters***, such as people who donated to the campaign or generally interested in the topic (e.g. Figure 4). Supporters can provide authentic consumer feedback, which helps novice crowdfunders adjust the design of the final product or service being funded. For instance, one participant creating a product that interfaces game controllers with DIY electronics projects described how he received feedback on what features his product could include.

> *"You also get very fast feedback about your project. So, in the course of running this campaign, a lot of people will ask me for features like, 'Hey can your project do this,' and I'll be like, 'No, but it could.' And I'll just go and add some software and add some computer code and be like, 'Okay, yea, I have this feature now.' So it's a good tool to get an idea of what people like and what people don't like about your project." (P56)*

Another creator of a publishing project described how he got *"hundreds of people"* to send comments on his book text (P31).

While supporters are less likely to have knowledge on how to run a campaign, they are inherently motivated to be a source of consumer feedback, which helped participants inform design changes and future strategy. For instance, one participant described how her team member posted a video blog post reflecting on what went wrong in the campaign. In response, their supporters sent feedback on the campaign design in addition to words of encouragement. Others even sent information about non-crowdfunding funding sources, highlighting how feedback from supporters can encourage novice crowdfunders to participate in the broader entrepreneurial work of pivoting when encountering barriers. One participant described how

feedback from supporters in his first unsuccessful campaign helped him redesign his re-launched successful campaign.

> *"I also, you know, made some tweaks and things about the rewards. Part of that was in response to feedback I had from people interested in the campaign the first time. So, I listened to that feedback. I thought about what might be reasonable to change or tweak, and I tweaked those things."* (P40)

P40 lowered his funding goal from $8,000 to $6,000 in the re-launched campaign, and ended up raising over twice as much the second time around to reach his goal of $10,000.

However, seeking feedback was not always easy. Participants described difficulty motivating people to spend time giving in-depth feedback and feedback before campaign launch. In order to address the challenge of seeking timely advice, Kickstarter launched a feature called Kickstarter Campus, which allows crowdfunders to post their work and receive feedback and advice (Kickstarter, n.d.-a).

I find that novice crowdfunders more often seek process feedback from domain experts (e.g. professional videographers) and peers (e.g. other crowdfunders), and product/service feedback from supporters (e.g. people who provide funding). The ability to receive coaching depended on novice crowdfunders' ability to build and manage their social networks in order to access relevant information and resources at the right time.

4.5.3 Explain Process to Maintain Relationships

Explaining work to supporters, such as describing one's product manufacturing process in social media updates, provides an opportunity for novice crowdfunders to develop skills through

articulation. Articulation involves any method of getting novices to describe their knowledge, reasoning, and problem solving processes (Collins, 2006). Unlike in cognitive apprenticeship, where articulation is initiated by a pedagogical domain expert (e.g. teacher), articulation in distributed apprenticeship is initiated by a ***distributed network*** of ***supporters***, such as people who request updates and detailed project descriptions in return for investing financial or social support.

Because crowdfunding work is done in a ***workplace context*** where activity is public and held accountable by real consumers, crowdfunders are expected to develop relationships with their supporters by answering questions about product designs, elaborating on their production processes, and posting frequent updates—responsibilities typically outside the scope of selling products in traditional brick-and-mortar stores or online marketplaces, like Amazon. For instance, one participant who raised funds for a local bee-keeping venture described the amount of time she dedicated to managing communication and social media in addition to designing and producing the final product.

> *"I respond to every question or comment, almost every comment on the Kickstarter page...You have to be prepared to devote 4-5 hours a day just making sure that you are promoting it or following up on it you know, or anything like that." (P10)*

Previous work on funder motivations finds that many supporters want to know more about the design process because they see themselves as investors rather than just consumers (Gerber & Hui, 2013; Kim, Shaw, Zhang, & Gerber, 2017). Because crowdfunding supporters are giving funds months in advance, they tend to feel more personally invested in the project's success and final design (Gerber & Hui, 2013).

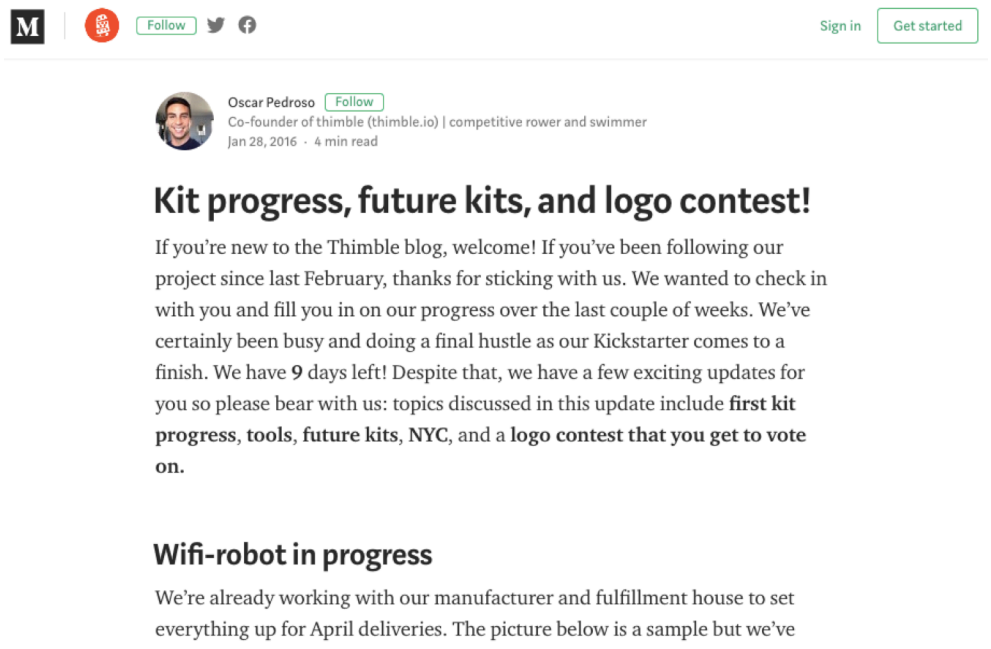

Figure 5. Example of explaining one's project progress to supporters through a public article (Pedroso, 2016). Posting these updates not only helps maintain supporter relationships, but also provides an opportunity to articulate one's decision and work process.

Having supporters provides a way to ***scale articulation*** because supporters are inherently motivated to request articulation activity through pitches, updates, and Q&A. Participants found the act of pitching to be a useful way to think through and articulate their project goals. For instance, a participant raising funds to build an urban garden described,

> *"You have to be able to talk to people and explain what you're doing…You're always figuring out different ways to explain your story or your plot or your project to people so they can understand it. So, I would say I definitely learned communication skills a lot more and it was very helpful." (P40)*

However, not all pitches include articulation. Articulation requires getting novices to describe their knowledge, reasoning, and problem solving processes (Collins, 2006), while pitching requires using certain rhetorical strategies to effectively describe one's work to increase the

likelihood of a response (Arguello et al., 2006). In analyzing crowdfunding pitches in campaign project descriptions and videos, I found that they often included articulation activity (e.g. explaining design process, production process, budget plans) in addition to pitching activity (e.g. describing design features, why their product is better than others). For instance, on a crowdfunding campaign page that raised $71,000 to launch a new brewery, the crowdfunders included traditional pitch information—*"Phenomenal beer, mind-blowing technology. Become a Braxton Building and help create the taproom of the future,"* and articulated their reasoning and problem solving process in the Risks and Challenges section (Rouse, 2014):

> *"With all new business ventures some degree of risk does exist and as responsible business owners, we feel obligated to explain them… Many of our rewards rely on vendors for fulfillment: a problem with any one of them could lead to delays or a change of plans. We would seek new vendors as soon as a problem arose, but there are no guarantees we could produce identical rewards in some cases."*

I find similar articulation activity in project updates (e.g. Figure 5). For instance, one creator of a tabletop game project described how he uses a combination of videos, blogging, campaign page feeds, and social media to verbally and visually share his design process and give updates on his progress:

> *"I will make sure that I send updates on how it's going…I'm able to share like say real time or a timeline of videos of how I layout a book or something or design a logo. And so I can share the process as it goes through, and the backers appreciate that and that seems to kind of build up, again, trust that I can fulfill on these projects." (P35)*

Articulation does not always happen in real-time, especially in work where voicing one's thought process interferes with work in the moment. Yet, with advances in live video technology, I see an increase in live articulation on Facebook Live, Instagram Live, Snapchat, and most recently, Kickstarter Live. These live videos are often used for Q&A sessions, where supporters post questions on a live comment thread or via social media channels (e.g. Twitter), and crowdfunders respond. For instance, in a live Q&A by a crowdfunding team raising funds to design a new backpack ("Livefree backpack live Q&A," 2017), they explain why they chose Kickstarter over other funding options, why they chose certain product materials, why they chose a certain manufacturing company, and how they plan to ship rewards on time, all of which fall under articulation activity of describing knowledge, reasoning, and problem solving processes.

However, the expectation to develop relationships with one's supporters may hinder novice crowdfunders to perform articulation effectively because they are at risk of being judged negatively, and therefore not funded. While I do not have data showing if and how participants censor what they share about their projects, it is likely that novice crowdfunders feel more comfortable articulating their thought process on "safer" topics, like design, rather than issues with their budget plans. Articulation on these riskier topics often happen in campaign updates when supporters demand explanations after certain issues surface, such as reward delays (Kim et al., 2017).

Being able to articulate one's work is necessary for learning how to seek feedback from coaches, communicate project plans to supporters, and think through one's assumptions. The public nature of performing entrepreneurship on crowdfunding platforms is different from other online marketplaces (Kim et al., 2017), like Amazon, where people go to buy a product with

little interest in knowing who the designer was and why something was designed in a certain way. Instead, crowdfunding supporters often expect to have design and business decisions explained to them in order motivate them to fund the project (Gerber & Hui, 2013). This demand for regular contact with supporters drives opportunities for articulation by forcing crowdfunders to repeatedly describe the state and purpose of their work.

4.5.4 Share Reflection to Support Community Wellbeing

After running the campaign, novice crowdfunders ***reflect*** on their work experience in written and video posts summarizing challenges they faced, lessons for others, and plans for future work. Reflection is a key component of the learning process because it provides an opportunity to improve one's mental models and develop self-efficacy by assessing improvements in performance and determining what to change in order to meet or exceed a certain standard (Collins et al., 1991; Van Merriënboer & Kirschner, 2012; B. J. Zimmerman & Schunk, 2011). Unlike traditional cognitive apprenticeship where reflection is prompted by an expert instructor, reflection in crowdfunding is prompted by a ***distributed network*** of ***non-expert instructors***, including peers and supporters. ***Peers*** drive opportunities for reflection by asking for feedback and advice on their own crowdfunding work, while ***supporters*** drive reflection by expecting an overview of the crowdfunding experience in exchange for potential future financial or social support.

By providing advice and feedback to peers through blog posts, YouTube videos, and online forums, crowdfunding entrepreneurs must reflect on their experience, make sense of it, and communicate lessons so that novices can apply them to their own work. For instance, one

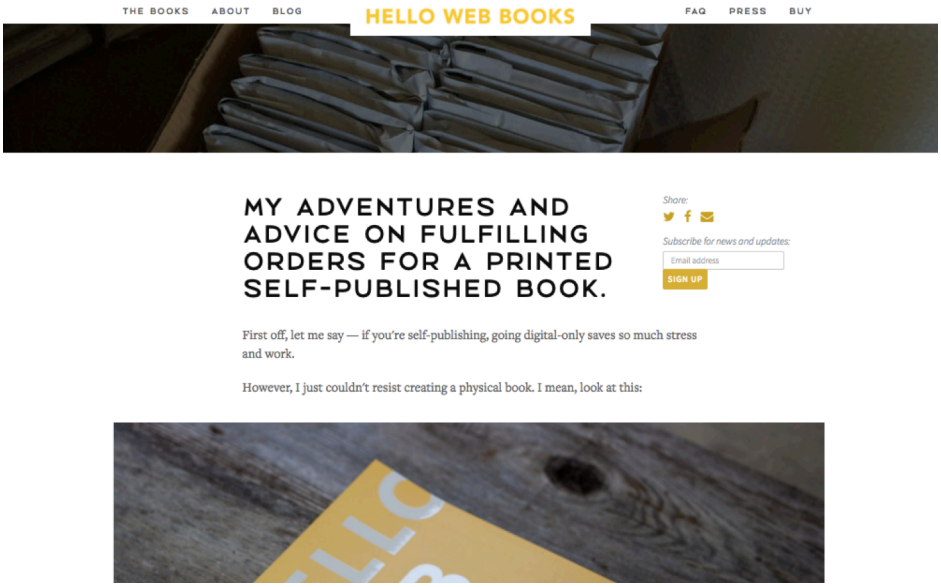

Figure 6. Example of a blog post describing what they learned from running a crowdfunding campaign to fund a self-published book (Osborn, 2015). Posting these reflections not only benefits novices in the crowdfunding community, but also provides an opportunity to reflect on one's experiences, a key part of skill development.

participant, who has raised $100,000 over four successful crowdfunding campaigns described how he provides advice through email to the many crowdfunding peers who reached out to him:

> *"Every week or so somebody emails me asking questions about Kickstarter like, 'My project got rejected by Kickstarter, how do I redo it?' And I'm like, 'You need to change this, this and this in your proposal, or you need to add this.'" (P6)*

As described in earlier sections, lessons shared by more experienced crowdfunders serve as models and coaching for novices. In observations of online crowdfunding activity, there were various examples of reflection in public blogs written to support crowdfunding peers (e.g. Figure 6). For instance, one crowdfunder wrote an article titled, *"How we failed in our first Kickstarter campaign, only to nail it with the second,"* in which he describes identifying and addressing initial mistakes to inform future strategy changes, such as how to build a community, set a

funding goal, format images and video, organize publicity, and manage shipping and rewards (Habich, 2015):

> *"I can't emphasize enough how vastly we underestimated this aspect [of community] the first time we tried Kickstarter. We didn't have a big user base, or a good variety of contacts, quite the opposite to be honest…You need to start with people that are thrilled about your product. They can give you feedback to perfect your campaign before launch and they will help create traction once you are live…This how to do it."*

In addition to providing advice and feedback through direct messages, sharing public posts through social media and online publishing platforms allow experienced crowdfunders to make sense of their own experiences in the process of helping peers. This public reflection process supports "socialization" of newcomers by having more experienced members of the community teach new members community norms and behaviors (Wenger, 1999), a practice shown to help sustain online communities (Kraut & Resnick, 2012).

This growing pool of novice crowdfunders provides a way to ***scale reflection*** as they seek and consume advice, motivating other crowdfunders to continue posting reflections for community benefit. Participants who have launched multiple successful crowdfunding campaigns described becoming well-known mentors in the crowdfunding community (P6, P9, P32, P35) and that the number of people reaching out to them for help has significantly increased over the years. While they hope to support those who reach out for advice, these experienced members often become overwhelmed with requests. Some participants described using social media to scaffold advice giving. For example, P35 described directing people to a Pinterest page

in which he curates and shares blog posts and articles before agreeing to speak with them one-on-one:

> *"I've put [advice] on a Pinterest board that I try to share when people come to me now and ask, 'How do I do a Kickstarter?'...Kickstarter itself actually documents some of these answers, but I think people just look at it and kind of get a little, I don't know, glassy-eyed? And so, to an extent, they're just looking for, 'Well, where do I start trying to figure out what I want to do here,' and that's what the pin board was for."*

Since then, Kickstarter has launched it's own guide to walk novice crowdfunders through this process ("Kickstarter Guide," n.d.). Because crowdfunding takes place in a ***workplace context***, novices are responsible for maintaining relationships with those who invested in their development. Supporters often expect to be updated on the state of the project and plans for the future (Gerber & Hui, 2013). Following their failed campaign, P22 and her project partner chose to keep their supporters informed by posting a video post on the campaign page in which they reflected on mistakes made and plans to potentially re-launch. In the video, P22's project partner attributed their failure to the fact that they tried to raise funds for multiple products at once. He explained that in the next iteration of the campaign, they would focus on the design and implementation of one product, a vending machine to promote healthy eating among children, rather than trying to raise funds for a series of machines at multiple schools. As described in the previous section on seeking advice and feedback from extended networks, these posted reflections also allow supporters a chance to provide further social support to overcome failure. In response to P22's video, supporters sent words of encouragement and introductions to schools that would benefit from the project, as well as alternative sources of funding.

Continued participation from crowdfunding peers and supporters can promote reflection by informing strategies for adjustment and stronger self-efficacy. While reflection often occurs naturally, the social nature of crowdfunding makes it possible for people within the crowdfunding community to help initiate and promote reflection.

4.6 Design Implications

I provide design implications describing specific ways that social technologies can be improved or implemented so that novice entrepreneurs have greater opportunities to experience instruction through interactions with other community members. Table 3 summarizes these design principles and how they could be carried out in the context of crowdfunding.

4.6.1 Support Search via Instructional Attributes

Unlike traditional and cognitive apprenticeship where there are dedicated instructors who create and share examples for the purpose of instruction, such as in classrooms (Collins et al., 1991) and MOOCs (Gulwani, 2014), crowdfunders must identify and make sense of examples provided by non-expert instructors. Crowdfunding platform search tools could help crowdfunders pinpoint successful strategies. For instance, if crowdfunders specifically wanted to identify useful communication strategies, platforms could identify projects of similar type, funding goal, reward structure, and social network of the crowdfunder, but with different communication formats and success outcomes. Learning via modeling often involves comparing successful to failed models in order to identify which actions to mimic and which to avoid (Bandura, 2001). Hiding failed projects limits opportunities to learn from "negative models" and may cause people to have

Design implication		Distributed apprenticeship method supported	Crowdfunding Example
1	***Support search via instructional attributes***	- Consult posted examples of peer work - Seek direct feedback from extended networks	Provide ability to search for successful and unsuccessful projects run by similar others.
2	***Facilitate feedback from multiple stakeholders***	- Seek direct feedback from extended networks - Explain process to maintain reputation	Facilitate relationships with feedback providers by suggesting ways to present work and timelines for updates.
3	***Support process documentation***	- Explain process to maintain reputation - Share reflection to support community wellbeing	Provide opportunities to share progress on a pre-launch page in order to build a consumer following.

Table 5. Design implications for improving learning opportunities in distributed apprenticeship.

unrealistic expectations of success. While it may be against the interests of crowdfunding platforms to highlight failed projects among the general public, platforms could provide tools specific for crowdfunders that help them identify successful and failed campaigns that serve as particularly useful instructional models.

Platforms could also facilitate search of instructional models by making important invisible factors of success more visible. One of the main reasons identifying successful practices is so difficult is because much of crowdfunding success depends on one's initial social capital (Mollick, 2013), a measure typically absent on campaign pages. In our interviews, I encountered many people who believed achieving success would be simple after seeing the ease by which others raised funds, not knowing how their social capital compared. Being able to find people with similar social capital, such as others with similar social network position and size, would help crowdfunders set more realistic expectations of success based on their own network.

The growing number of crowdfunding projects online provides a rich repository from which novices could learn. Providing search functionality to identify relevant models would help novices better plan their work and develop useful mentor relationships.

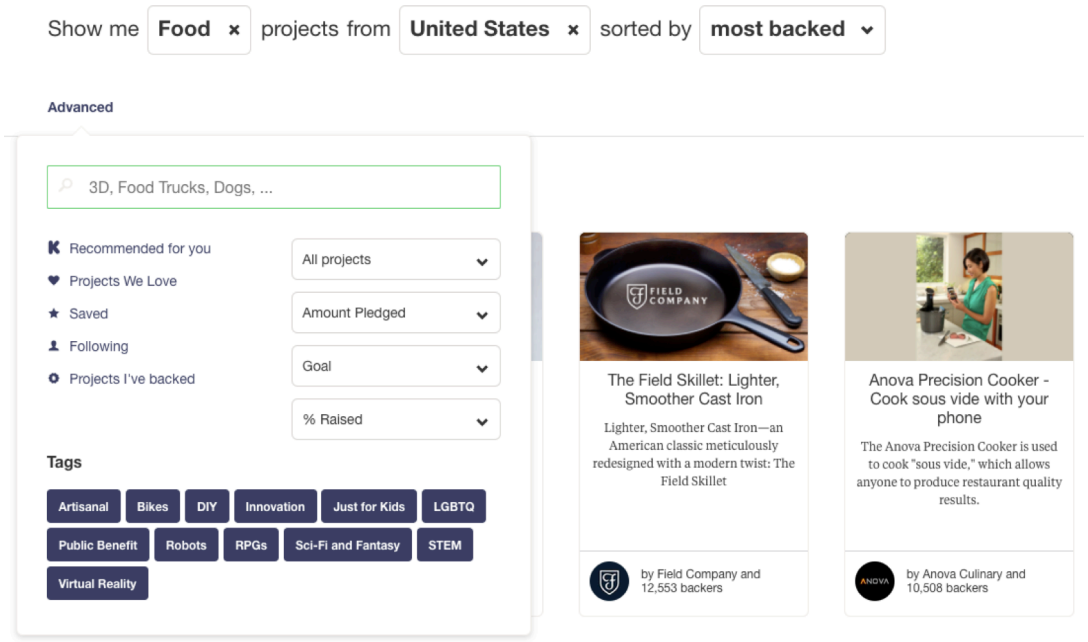

Figure 7. Kickstarter's search primarily allows users to search for successful projects by general project type, location, and certain success factors.

4.6.2 Facilitate Feedback From Multiple Stakeholders

Scaffolding interactions to receive advice and feedback is particularly important for novices who need extra guidance on performing the many complex aspects of crowdfunding work. In order to receive and benefit from online feedback, requesters must determine their need for feedback, identify feedback providers, effectively present work, incentivize feedback providers, make sense of feedback, and adapt it to their revisions (Foong, Dow, Bailey, & Gerber, 2017).

I find that crowdfunders who were not part of an immediate network of people willing to offer and help, such as a school or artistic community, had difficulty collecting advice and feedback. Furthermore, our data also shows that those who have come to be mentors in the crowdfunding community are also inundated with requests for help, especially as crowdfunding continues to grow in popularity. Algorithms to efficiently distribute feedback requests or

organize peer feedback (Staubitz, Petrick, Bauer, Renz, & Meinel, 2016) could be adopted by crowdfunding platforms to reduce the burden on those who are experienced, but have limited time. Those who do end up providing significantly more help to peers could be acknowledged by crowdfunding platforms for their service, a suggestion made in MOOC contexts to reduce anti-reciprocal peer review (Kotturi, Du, Klemmer, & Kulkarni, 2017).

Our work highlights how different strategies must be adopted to motivate and facilitate feedback from different stakeholders in distributed informal workplace communities. While there has been much work on supporting feedback on distributed communities, the majority of this work has been performed with peers in MOOCS and paid crowd workers. I identify how feedback exchange in distributed informal workplace communities needs to be treated differently as feedback providers are not paid and have higher expectations.

4.6.3 Support Process Documentation

Unlike traditional forms of modeling where an expert performs an entire task for the purpose of instruction, there are limited opportunities for observing work process online. This is a problem in related contexts, like online creative communities where members primarily post only their finished products to maintain a professional reputation (Marlow & Dabbish, 2014). HCI researchers and practitioners have begun to develop various online platforms that encourage people working on design and engineering projects to elaborate on their process (Rees Lewis et al., 2015; Tseng & Resnick, 2014). However, many find that people are wary of posting their process because they have little motivation to spend the extra time and do not want to be judged on early versions of their work (Marlow & Dabbish, 2014; Tseng & Resnick, 2014).

While process documentation can be time consuming, it can support in-the-moment assessment and documentation during complex fast-paced work like entrepreneurship (Shane, 2003). Related work on checklists (de Vries et al., 2010; Haynes et al., 2009; Wu et al., 2014) and version control systems (Brindescu, Codoban, Shmarkatiuk, & Dig, 2014; Mikami, Sakamoto, & Igarashi, 2017) have shown how tools that support process documentation can help manage complexity, help error recovery, and support more efficient collaboration in high-stress complex work environments. For instance, crowdfunding platforms could outline key responsibilities before, during, and after the campaign to share with domain experts, peers, and supporters. Similarly, blogs that host crowdfunding reflections could provide questions to help crowdfunding entrepreneurs reflect on different parts of their process, such as "What was most difficult during the first week of the campaign?" or "What are three things you would change if you were to crowdfund again?" which could support reflection that can be easily shared with peers looking for advice. Such supports could reduce cognitive burden for crowdfunders.

4.7 Discussion

Entrepreneurship is experiencing a revolution through crowdfunding, as entrepreneurs must learn to interact not just with a handful of team members and investors, but also with members of an entire online community of peers, experts, and supporters to perform a wide range of work. Unlike crowdfunding, entrepreneurial researchers have found that, less than 30% of entrepreneurs typically maintain direct or indirect ties with customers (Bhide, 2000). Conversely, crowdfunding entrepreneurs are often motivated to build lasting relationships with their supporters by building online communities (Kraut & Resnick, 2012), such as engaging with

supporters directly, explaining the value of their project (Kazanjian, 1988), coordinating efforts with supporters (Hui, Greenberg, et al., 2014), and motivating activity via extrinsic tangible rewards or intrinsic rewards of gratitude (Gerber & Hui, 2013). In order to support skill development in informal workplace communities with limited access to dedicated expert instructors, these communities should design and adopt systems that provide a diversity of avenues to apprentice-like instruction, including access to representations of each others' work, ways to communicate process and reflections to different stakeholders, and opportunities to seek relevant advice and feedback.

I develop an emergent theory of distributed apprenticeship, which describes the process by which social interactions in informal online workplace contexts, like crowdfunding, foster opportunities for apprentice-like instruction. I argue that in order to mimic the benefits of dedicated instructional guidance, these communities should provide examples of peer work, support feedback from extended networks, encourage process sharing to maintain relationships, and facilitate reflection. These findings provide implications for how communities can be designed to provide novices greater opportunity to experience apprentice-like instruction in online informal workplace communities.

While distributed informal entrepreneurial communities have changed how we participate in authentic entrepreneurial practice, they have also introduced new and understudied challenges to how to best develop and leverage these relationships. For example, simply seeing others work doesn't mean you know how to apply their skills, or simply knowing who has skills, doesn't mean you know how to develop a relationship with them. These are open questions in HCI, which I begin to address in the final study.

5. INTROASSIST: A TOOL TO SUPPORT WRITING INTRODUCTORY HELP REQUESTS

5.1 Introduction

Building a strong and diverse social network is necessary for entrepreneurship, where resources are often accessed through relationships (Shane, 2003). While a plethora of Internet technologies have been created to build professional connections, people still face social, psychological, and skill-based barriers to contacting others (Dillahunt, 2014; DiMaggio, Hargittai, & others, 2001). Researchers studying the role of technology in facilitating professional connections have found that people often don't know how to identify helpful others among the potentially millions available (Mahmud, Zhou, Megiddo, Nichols, & Drews, 2013). But, perhaps most importantly, many have not been taught how to even initiate new connections (Dillahunt, Bose, Diwan, & Chen-Phang, 2016). Even if an algorithm recommends an ideal match based on target expertise, willingness to help, or similar interests (Bouguessa, Dumoulin, & Wang, 2008; Horowitz & Kamvar, 2010; Jurczyk & Agichtein, 2007; Liu, Croft, & Koll, 2005; Mahmud et al., 2013; McDonald & Ackerman, 2000; Pal, Farzan, Konstan, & Kraut, 2011; J. Zhang, Ackerman, Adamic, & Nam, 2007), people reaching out might still fail to send a help request that resonates with the receiver enough for them to respond.

Understanding how to initiate professional relationship development is an age-old problem, and it will only increase in complexity as the cost of communication decreases. While distributed apprenticeship in informal communities have changed how people participate in entrepreneurial practice, they have also introduced new and understudied challenges to how to best develop relationships with a diverse range of community members. In this study, I design

and evaluate a system, IntroAssist, that scaffolds the initiation of professional connections through online written introductory help requests.

Introductory help requests are requests where 1) the requestor has never met or interacted with the receiver, and 2) responses take a significant amount of time, effort, and/or social capital to fulfill. Introductory help requests often motivate new connections in professional settings because people are highly motivated to reach out to others when they are in need of support (Gino, Brooks, & Schweitzer, 2012). Specifically, I study how to support writing the first message to a new contact who could provide *help*, which I define broadly as any form of needed financial, social, human, or informational resource. For example, this might include writing an email to a new contact requesting a 20-minute conversation for feedback on one's project, or to be connected to a respected colleague.

Previous literature has typically studied help requests from people that are already within one's social network (Ellison, Gray, Vitak, Lampe, & Fiore, 2013; Morris, Teevan, & Panovich, 2010) or requests that do not take a significant amount of effort to respond, such as quick feedback (Foong et al., 2017; Xu, Huang, et al., 2014) or recommendations (Morris et al., 2010). While these types of help requests are useful for entrepreneurs, they do not require many of the particularly challenging aspects of professional relationship development, such as establishing oneself as reputable, building trust, and motivating a higher-effort response (Grodal, Nelson, & Siino, 2015).

A successful help-seeking scenario involves identifying someone who is able and willing to provide help, and having the confidence and skills to reach out effectively. The majority of previous research on help-seeking in HCI has primarily focused on identifying an ideal help

giver—someone who has relevant expertise and willing to provide help (Bouguessa et al., 2008; Horowitz & Kamvar, 2010; Jurczyk & Agichtein, 2007; Liu et al., 2005; Mahmud et al., 2013; McDonald & Ackerman, 2000; Pal et al., 2011; J. Zhang et al., 2007, 2007; Zhou, Cong, Cui, Jensen, & Yao, 2009). However, simply knowing who to ask for help does not mean novice entrepreneurs will necessary have the confidence or skills to reach out effectively (Gall, 1985; Nelson-Le Gall, 1981). In this study, I ask, ***How might we leverage cognitive apprenticeship instructional methods of modeling, coaching, and reflection in an online context to support help seekers in writing introductory help requests?***

To address our research question, I create and test IntroAssist, a web-based tool that supports writing of introductory help requests through an expert-informed checklist, tagged peer examples, reflection through self-tagging, and suggested word limit. To design IntroAssist, I draw from relevant research in learning sciences, human computer interaction (HCI), and management, as well as a needfinding study, to understand how to best support introductory help seeking behavior.

I chose to develop and test IntroAssist in the context of entrepreneurship, where the work heavily relies on help seeking, but where there often is no preexisting relationship or expectation to provide support to others, making the act of help seeking even more challenging (Shane, 2003). Our evaluation of IntroAssist with 26 novice entrepreneurs reveals that our tool design increases the quality of written introductory help requests, supports performance of introductory help seeking skills after the tool is removed, and makes help seekers more likely to report sending these help requests. Additionally, I provide implications for how Internet technologies could better initiate the development of social capital in professional settings.

5.2 Help Seeking in Professional Settings

Across domains (Peter Michael Blau, 1964; O'Reilly & Chatman, 1986; C. A. Smith, Organ, & Near, 1983), extensive literature highlights the key role that help seekers play in initiating help-seeking interactions. For instance, management scholars find that 90% of help seeking interactions are initiated by help seekers (Burke, Weir, & Duncan, 1976), with similar results found in multiple professional contexts over the years (Anderson & Williams, 1996; Nadler, 1991).

Help seeking is a complex process that involves multiple steps in both self-awareness and applying communication skills (Grodal et al., 2015; Nelson-Le Gall, 1981). Seminal work on help seeking in educational contexts describes a five-step process to seeking help: 1) being aware of needing help, 2) deciding to seek help, 3) identifying potential helpers, 4) employing strategies to elicit help, and 5) reacting to the help seeking attempt (Nelson-Le Gall, 1981). Our work focuses specifically on stage 4) employing strategies to elicit help as few researchers have focused on supporting people in developing skills needed to initiate these interactions effectively (Bamberger, 2009).

In professional settings, people tend to help others who might help them later (Gouldner, 1960) and in order to gain status from professional peers (Peter Michael Blau, 1964; McNeely & Meglino, 1994). Others decide whether to give help depending on the level of trust they have of the help seeker (Kramer & Tyler, 1996) and perceptions of the help seeker's status (Flynn, Reagans, Amanatullah, & Ames, 2006). Linguists find that language that elicit positive emotions and reciprocity are more likely to get a positive help giving responses online (Gorbatai & Nelson, 2015; Mitra & Gilbert, 2014), findings based in extensive psychology literature on

influence (Cialdini, 2001). All this is to say that carrying out a help seeking interaction requires a wide range of cognitive and emotional engagement (Grodal et al., 2015), which can be overwhelming to help-seekers reaching out to someone for the first time.

The majority of studies on help seeking in professional contexts have focused on help seeking and giving in formal organizational settings, such as a company, where people often already know each other or are at least expected to provide help to peers for organizational purposes (Bamberger, 2009). In contrast, I study the case of *introductory* help seeking in *informal* workplace contexts, like entrepreneurship, where there is often no shared professional goal, preexisting relationship, or expectation to provide support to others (Shane, 2003). The lack of shared expectation of social support further exacerbates the already complicated requirements of help seeking in professional contexts, and is an understudied topic in the help seeking literature (Bamberger, 2009). In situations where there is no existing relationship, it often falls on the help seeker to figure out the many factors that play into why someone might provide help in the first place (Burke et al., 1976).

5.3 Help Seeking Support Tools

The skills needed to perform help seeking online has changed and in many ways become more complicated with the introduction of new social technologies (Puustinen & Rouet, 2009; Walraven, Brand-Gruwel, & Boshuizen, 2008). An ideal helper must have the skills to provide help, be willing to help, and be someone the user is willing to contact (Nadler, 1991). However, much HCI research has been focused on the first two requirements by building various recommender systems to find who has the most relevant knowledge and is most willing to help

in online social networks (Bouguessa et al., 2008; Horowitz & Kamvar, 2010; Jurczyk & Agichtein, 2007; Liu et al., 2005; Mahmud et al., 2013; McDonald & Ackerman, 2000; Pal et al., 2011; J. Zhang et al., 2007). Others have studied what network structures and search strategies lead to experts most quickly and using the least amount of social capital (J. Zhang & Ackerman, 2005). However, even if an ideal match is recommended, the help seeker might still fail in writing a request that resonates with the help provider (Cialdini, 2001) or even have the confidence to send it (Ryan, Gheen, & Midgley, 1998; Ryan, Pintrich, & Midgley, 2001). Failing to support the help seeker in writing and sending these help requests will ultimately lead to unrealized opportunities in initiating professional interactions.

The few HCI studies that have focused on the help seeker's perspective have mostly been performed in formal organizational contexts (Shami, Ehrlich, Gay, & Hancock, 2009; Shami, Ehrlich, & Millen, 2008; Yarosh, Matthews, & Zhou, 2012; Yarosh et al., 2013). For instance, researchers studying IBM's enterprise communication platform found that surfacing additional expert features, such as company division, expertise summary, and online social activity, helped subjects make a more informed decision when identifying an expert and in a shorter amount of time (Shami et al., 2009; Yarosh et al., 2012). However, they also argue that help seeking is still not well supported by current tools because they did not facilitate the interpersonal trust needed for more complex help seeking transactions to occur (Yarosh et al., 2013). Our work answers the call to better facilitate these complex interactions by facilitating the writing of introductory help requests in informal workplace contexts where there is likely to be limited shared trust and requirements to help each other (Bamberger, 2009; Shane, 2003).

Outside of academia, industry practitioners have provided multiple resources to support introductory help seeking in the form of how-to articles (Snow, 2014), marketing tools ("Mailchimp," n.d.), and email analysis tools ("Boomerang for Gmail," n.d.). Although how-to articles exist, help seekers may struggle to understand how to apply these practices to their own situations. For instance, state-of-the art emails support tools, like Boomerang's Respondable feature ("Boomerang for Gmail," n.d.), only indicate how likely one's email might receive a response based on language and length, but does not provide support in writing the message in the first place.

5.4 Hypotheses

Through the design of IntroAssist, I explore whether it is possible to apply instructional mechanisms of cognitive apprenticeship (Collins, 2006) to scale teaching of help seeking skills in an online context. Specifically, I apply the cognitive apprenticeship mechanisms of *modeling*, *coaching*, and *reflection* (Collins, 2006). To reiterate, *Modeling* involves an expert performing a task so that learners can watch and emulate their processes; *Coaching* involves having someone provide feedback and advice as they see fit or as problems arise; *Reflection* involves encouraging the learner to evaluate their performance by comparing their work to a mental model or others' work, and identifying opportunities for improvement. I apply these mechanisms into the design of IntroAssist to facilitate the writing of introductory help requests in the absence of in-person expert guidance.

The aim of this study is to investigate how to design a support tool that can facilitate help seekers skill in writing introductory help requests and increase their confidence in sending these help requests. I present the following hypotheses:

- **Hypothesis 1:** The overall quality of the introductory help requests written with the tool will be higher than help requests written without exposure to the tool.

Hypothesis 1 is motivated by related work in apprenticeship showing instruction that supports modeling, coaching, and reflection to be highly effective in teaching complex tasks (Collins, 2006).

- **Hypothesis 2:** Help seekers will continue to be able to perform introductory help seeking skills after the tool is removed.

While allowing help seekers to continuously use the tool indefinitely is an option, it is important to know whether these lessons could be applied to situations where the tool might not be easily available. Hypothesis 2 is based on previous work highlighting the importance of learning-by-doing in supporting knowledge retention (Lave & Wenger, 1991; Rogoff, 2003; Vygotsky & Cole, 1978).

- **Hypothesis 3:** Help seekers will be more confident in sending their written help requests after being exposed to the tool.

Because help-seekers typically initiate contact with help providers in professional contexts (Burke et al., 1976), I see likeliness to send help requests as an important and desired outcome. Hypothesis 3 is based on related work describing how believing that one has the skills in a

certain task makes one more likely to perform the task itself (Bandura, 2001), especially in the context of help seeking (Ryan et al., 1998, 2001).

5.5 Design Process

I followed a design research process (Easterday, Rees Lewis, & Gerber, 2017; J. Zimmerman et al., 2007), which involved performing initial exploratory qualitative data collection from help seekers and help providers, using these insights to inform my design goals, and developing and testing a paper prototype before building the fully functional final design.

5.5.1 Preliminary Qualitative Data Collection

To develop an initial understanding of the help seeker perspective, I performed preliminary qualitative data collection with novice entrepreneurs in the early stages of new ventures within a university incubator space and extracurricular entrepreneurship groups. I interviewed nine help seekers (5 F, 4 M) and performed a 1.5 hour-long participatory design workshop with five additional help seekers (3 F, 2 M). During interviews, help seekers were asked to describe their most recent online help seeking experience and to reflect on what was easy or difficult about this process. Interviews lasted on average 20 minutes. During, the workshop I asked participants to reflect on all the possible reasons why they have not reached out to certain people for help in a professional context, and to brainstorm ideas for encouraging and supporting help seekers, like themselves, to reach out for help in the future.

To understand the help provider perspective, I performed interviews with seven help providers (3 F, 4 M), identified as people who have received help requests from novice

entrepreneurs, have over five years of professional experience, and receive at least one online introductory help request a week, such as requests for information about their organization or work opportunities. During the interview, I asked help providers to reflect on the most recent introductory help request that they received via email and what they liked and disliked about this request. I then asked help providers to describe the most common mistakes help seekers tend to make. Interviews lasted on average 20 minutes.

I analyzed interview transcripts and workshop data (notes and post-its from brainstorms) using inductive coding methods (Miles & Huberman, 1994) in which I coded for main challenges with help seeking and help giving. From this initial exploratory data collection, I identify reasons help seekers struggle to write introductory help requests, and the main requirements for successful introductory help requests as identified by help providers.

5.5.2 Preliminary Qualitative Findings

Help seeker perspective

All help seeker participants shared anxieties about how to best attract a help provider's attention, but had different approaches to dealing with this challenge. For instance, one participant described taking multiple days to figure out how to pitch her work to someone whom she saw as more experienced, *"The entire process took me several days and it caused a lot of anxiety about how I would introduce and portray myself, pitch myself, and also speak to [their] interests."* Others took a very different approach, sending out as many, almost identical, help requests as possible expecting that most people would not respond.

While there are multiple resources explaining what to include in introductory help requests (e.g. (Snow, 2014)), participants described having trouble understanding how to apply these suggestions to their own situations. For example, a participant who was part of a team working on a product design entrepreneurship project described how he did not know how to effectively "personalize" his help request to a local community stakeholder. In reviewing the help request he wrote, I found that he dedicated entire paragraph to describing the information he learned on the stakeholder's website, which buried his main question and made his overall message much longer and more difficult to read. I heard this difficulty of not knowing what content to include or language to use echoed among participants who were not taught strong communication skills at home or in school.

Overall, help seekers described the process of writing introductory help requests as highly stressful because they saw it as the main opportunity to connect with someone who could provide needed professional support. Participants primarily described not knowing what was considered appropriate content or language, and not having the confidence to even send these requests for fear of rejection.

Help provider perspective

Unfortunately, help provider participants described being inundated with introductory help requests, or *"bad emails"* as one called them. They generally had little sympathy for help requests that were unclear, impolite, or poorly written. The main complaints included not knowing enough about the sender, not understanding the request, or being annoyed by the type of request or tone.

For instance, one expert described receiving many emails about the organization that she runs in which people fail to introduce themselves, *"When people say I'm very interested in the [organization], is it a high school student? Who is this person?...This wouldn't be the kind of thing where like, oh! I got to respond to this right away! It would probably be down low on the list…I get emails like this that I just kind of ignored for a long time."* Others described not responding to emails because they did not understand what response was needed. One help provider explained a primary problem with emails that he receives, *"One of them is not asking for anything or being very unclear about what they are actually asking about. So, you get a lot of emails where it's not even possible to figure out what the person is trying to get at."*

Through coding of help provider transcripts, I identified seven main requirements for what help providers look for in a good introductory help request: 1) clarity of who is the help seeker (e.g. name, profession, organization), 2) understanding of connection to help seeker (e.g. mutual connection, mutual community), 3) understanding of why the help seeker is reaching out (e.g. project goals), 4) understanding of what is being asked, 5) demonstration that the help seeker has put in prior effort (e.g. reviewed online information first), 6) indication that the help request is personalized (e.g. explain why reach out to me), and 7) an appropriate tone (e.g. polite, professional). These preliminary findings reaffirm related work on what to include in successful help requests (Flynn et al., 2006; Gouldner, 1960; Kramer & Tyler, 1996; Snow, 2014).

5.5.3 Paper Prototype

Following the initial exploratory study of introductory help seeking behavior, I identified the need to build a tool that would both assist help seekers in developing the language to write

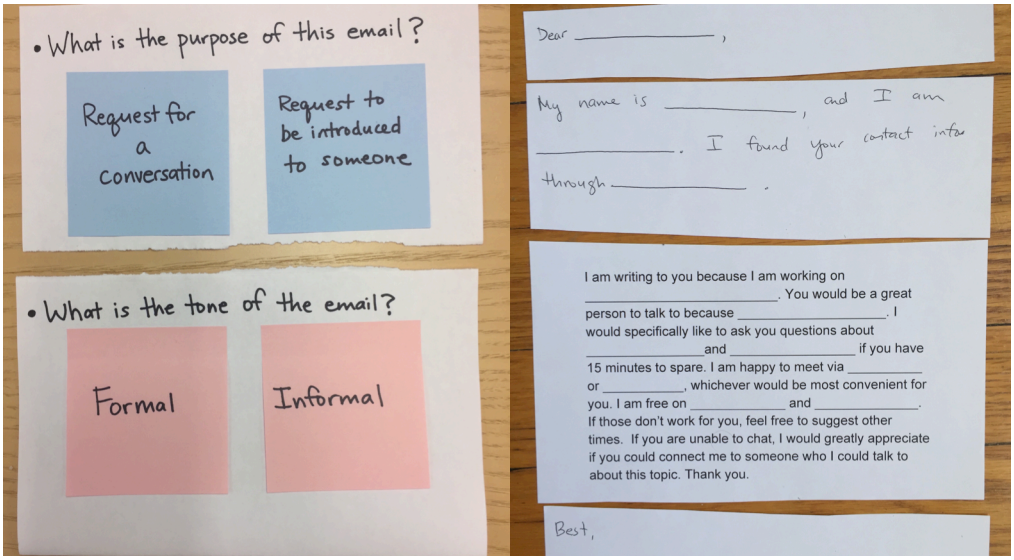

Figure 8: Build-a-Message helps craft a pre-written help request (Right) by having help seekers answer questions about their message (Left).

higher quality introductory help requests, as well as the confidence to send them. I first developed a paper prototype called Build-a-Message, which put together a message template based on the help seeker's needs.

I tested the paper prototype using wizard-of-oz methods (Hanington, 2012) where help seekers answered a few quick multiple choice questions about their type of help request (e.g. request for conversation) (Figure 8, left), and I, acting as the computer, pieced together an ideal template for help seekers to fill in (Figure 8, right). Help seeking participants were asked to perform a think-aloud as they interacted with the prototype.

Help seeker participants found the prototype mostly useful, but did not like that it reduced opportunities for personalization due to the fixed template. Even if the template could be editable, participants found that having the initial template limited their writing style. For instance, some expressed a fear of sounding "too generic," which might reduce their chances of

getting a response. Others described a distrust of the template, and wanted to know how it was developed, how often it was successful in the past, and for what scenarios. For example, one participant explained that there could be many different sentence structures to achieve the same help request, and preferred to look at different examples before deciding what style was most appropriate for her needs.

Help provider participants also expressed a strong dislike of knowing that a help request might have been mostly written by a tool rather than the help seekers themselves. Help providers expressed that the quality of writing was a significant indicator in helping them decide whether or not they wanted to respond. Having the tool write the majority of the help request would make it harder for help seekers to manage their help requests, and might make them even less likely to respond.

Following our design research approach, I took this feedback into account to develop my current functional design, which allows help seekers to view multiple examples in order to write the entire help request themselves.

5.5.4 IntroAssist Design

I designed IntroAssist as a web-based tool that leverages cognitive apprenticeship instructional methods to support writing introductory help requests. Unlike the earlier paper prototype, the affordances of this online tool allows us to show how items from an expert-informed checklist (Figure 9a) are instantiated through tagged examples of help requests (Figure 9b), supports reviewing of one's help request through self-tagging (Figure 9c), and encourages succinctness

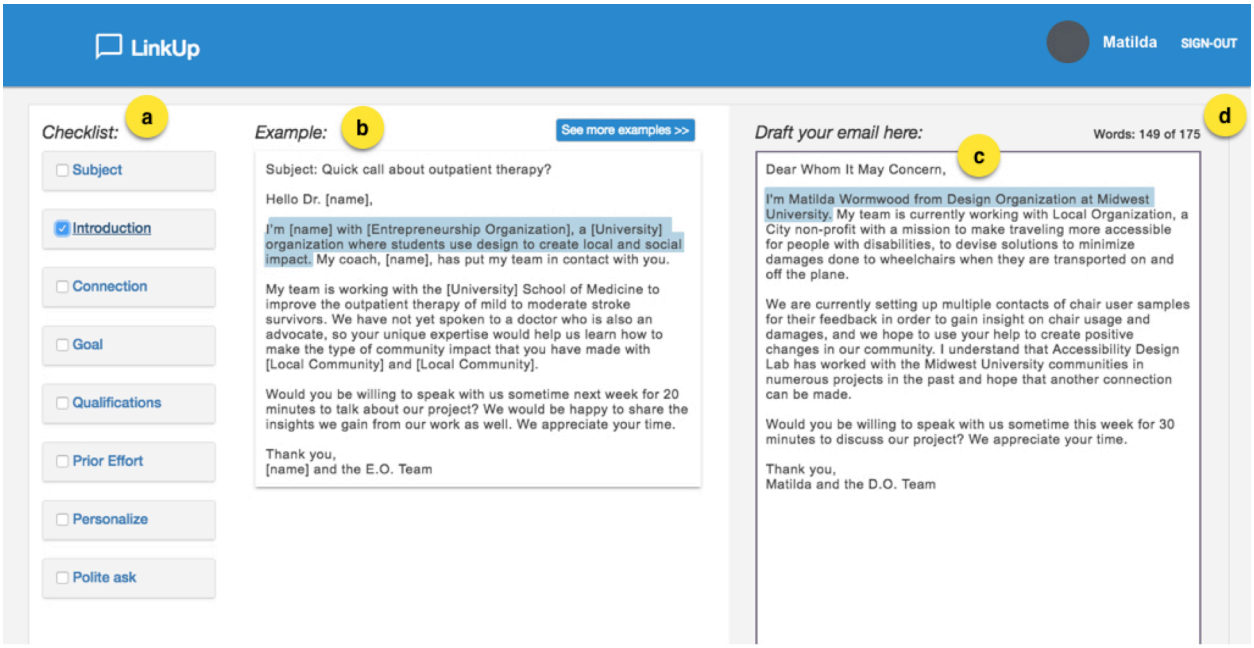

Figure 9: IntroAssist is a web-based tool to support the writing of introductory help requests. It includes (a) an expert-informed checklist of best practices, (b) tagged community examples, (c) tagging one's own help request, and (d) a word limit suggestion.

through a suggested word limit (Figure 9d). This prototype was built with Javascript, HTML, and CSS, using a Firebase database. The four main features of IntroAssist are outlined below:

Checklist of Best Practices: In order to share expectations of what to include in an introductory complex help request, IntroAssist provides a checklist of best practices informed by expert interviews (Figure 9a). The list of practices was informed by previous literature on what factors were important to help providers (Flynn et al., 2006; Gouldner, 1960; Kramer & Tyler, 1996; Snow, 2014) and the exploratory interviews performed with help providers. Providing a checklist simulates some benefits of *coaching* (Collins, 2006) by breaking down and describing the type of content to be included in the help request (Gawande, 2010; Haynes et al., 2009).

Tagged Peer Examples: In order to support making sense of other's help requests to inform one's own, IntroAssist provides tagged example help requests where relevant parts are highlighted depending on what item on the checklist is being focused on (Figure 9b). Examples, provided by members of the entrepreneurial communities studied during the earlier exploratory data collection, were selected by experienced help providers as particularly well written. Showing high quality tagged examples of others' work mimics the benefits of *modeling* (Collins, 2006), which has shown to increase learning of complex tasks by showing how others perform similar work (Doroudi, Kamar, Brunskill, & Horvitz, 2016).

Tagging of Own Help Request: In order to encourage novices to reflect on the quality and content of their own help request, IntroAssist encourages novices to tag their own written request with items on the checklist (Figure 9c). Tagging one's on help request encourages *reflection*, which supports knowledge retention (Collins, 2006).

Word Limit Suggestion: Finally, I include a word limit suggestion (Figure 9d). Previous work suggests that email around 125 words tend to get more responses (Alex, 2016). However, this finding was based on data analysis of all emails in general, where introducing oneself is not necessarily required. The chosen examples of introductory help requests provided in the tool were about 175 words or fewer, which was displayed as the suggested word limit.

5.6 Evaluation

In order to evaluate the efficacy of IntroAssist, I performed a within-subjects experiment in a community of 26 novice entrepreneurs. I collected both quantitative and qualitative data on the quality of help requests and help seeker experience.

5.6.1 Participants and Setting

Twenty-six participants (14 F, 12 M) were working on entrepreneurship projects over the summer at a Midwest private university. Twenty-one participants were part of a six-week long program for social entrepreneurs in which they worked full time in teams of 4-5 to develop a product or service with a community partner. The remaining five participants were working on independent projects related to education and health. Participants had minimal to no previous entrepreneurship training, and needed to write introductory help requests to organizations, mentors, and users in order to request conversations and access resources. For instance, one team was creating a product to improve airport accessibility. They had to write help requests to airport staff and wheelchair manufacturers to request interviews and on-site visits. Another participant was working to develop a mobile app related to exercise and needed to contact local running groups to ask if they would test her product. Participants were between the ages of 19 and 25, were currently in college (24 participants), recently graduated (1 participant) or in graduate school (1 participant). Two participants were non-native English speakers.

5.6.2 Experimental Setup

Each participant was asked to write two introductory help-requests. Fourteen participants were asked to write a request *without* the tool then a request *with* the tool (No Tool First), while 12 participants were asked to write a request *with* the tool then *without* the tool (Tool first). See Table 6. This setup allowed us to collect within-subjects data of how tool usage affected quality of written help requests controlling for when the tool was introduced. All participants were compensated with a $10 Amazon gift card.

Testing Session	**No Tool First** *(14 people)*	**Tool First** *(12 people)*
0-10 min.	Introduction to study	Introduction to study
10-20 min. (Request 1)	Write help request **without** tool (i.e. baseline)	Write help request **with** tool
20-30 min.	Survey A	Survey B
30-40 min. (Request 2)	Write help request **with** tool	Write help request **without** tool
40-50 min.	Survey B	Survey A
50-60 min.	Debrief and Discussion	Debrief and Discussion

Table 6: Participants were split between two conditions (No Tool First, Tool First), which determined when they were exposed to the tool treatment.

Testing sessions lasted one hour and were performed in groups of 1 to 5 (one computer per participant) to best accommodate the busy schedules of the entrepreneurship teams. In order to minimize social interaction during the experiment, I required team members to not speak to each other until all emails were written and surveys answered. Testing sessions started with an introduction explaining that I was testing an email tool. Participants were then asked to list people to whom they needed to write introductory help requests for their project work, and then

were randomly assigned one from the list for their first written help request and another for their second written help request. By writing to different people, I forced participants to write different content for each request.

After each help request, all participants were asked to answer a survey about their help seeking confidence (Table 6, Bottom) and overall impression of the tool. At the end of the session, an open discussion was held about what participants found easy or difficult with writing emails with or without the tool. All final discussions were recorded and analyzed. Data was collected over a period of two months.

5.6.3 Assessing Help Request Quality

To evaluate quality of the introductory help requests, two experienced help providers evaluated each help request on multiple measures (Table 6, top). Rater 1 (the second author on this paper) has over 20 years of industry experience and receives at least one introductory help requests each week. A second rater (Rater 2) was added to provide an independent opinion from the project process and to detect potential bias from Rater 1's evaluations. Rater 2 is a professional career advisor and specializes in helping engineers connect with employers for jobs and internships. Neither rater participated in data collection or knew which help request was written with or without the tool. Raters achieved a high agreement using a Cohen's Kappa test of inter-rater reliability (κ=0.93) in identifying which email between subjects was higher quality in the No Tool First condition.

The two raters were asked to independently evaluate all the help requests (total of 4-5 hours each). Raters evaluated each help request on a 7-point likert scale for 12 different features

Measures for Quality	Description (Help provider rater)	Supporting Tool Features
Clarity of introduction	You had a clear sense of who they are.	Checklist/Examples - Introduction
Perception of reputability	They established themselves as someone reputable.	Checklist/Examples - Connection
Work description	They clearly described their work or project.	Checklist/Examples - Goal
Personalization	They appropriately personalized the help request to you or your organization.	Checklist/Examples - Personalize
Prior Effort	You are confident they did everything they could prior to asking you for help.	Checklist/Examples - Prior Effort
Clarity of ask	You had a clear sense of what they are asking of you.	Checklist/Examples - Polite Ask
Politeness	They asked their help request in a polite manner.	Checklist/Examples - Polite Ask
Tone	They used an appropriate tone given what they were asking.	Checklist/Examples - All items
Succinctness	They used an appropriate amount of words for what they were asking of you.	Word count
Flow	The content of the help request was appropriately organized.	Examples (overall organization)
Overall Quality	How would you rate the overall quality of the help request.	All features
Measures for Confidence	**Description (Help seeker)**	**Supporting Tool Features**
Confidence in quality	You are confident in the quality of this email.	All features
Likelihood to send	You are likely are you to send this email as is.	All features

Table 7: Measures to evaluate help request quality (Top) and help provider confidence (Bottom). All measures were evaluated using a 7-point likert scale.

(Table 7, top). Rating was conducted individually and in person, so that raters could perform a talk aloud as they read through each help request. Raters were sent each help request to their email client so as to mimic an authentic introductory help-seeking scenario, and were asked to describe what they liked and disliked about each request.

5.6.4 Analysis

Overall, I analyzed 12 measures for quality of help requests (Table 7, top) and two measures for help seeker confidence (Table 7, bottom). The two independent variables included Tool Introduction and Assessment Time. ***Tool Introduction*** refers to whether participants are introduced to the tool when writing their first help request (Table 6, Tool First) or when writing

their second help request (Table 6, No Tool First). ***Assessment time*** refers to whether the help request being evaluated is the first request (Request 1) or second request (Request 2).

Statistical analysis of the rating data was performed using the Aligned Ranked Transform (ART) for non-parametric factorial ANOVAs to analyze if tool usage had an impact on help request quality or help seeker confidence. Analysis was performed using the ARTool package in R (Kay & Wobbrock, n.d.; Wobbrock, Findlater, Gergle, & Higgins, 2011). This is the most appropriate test because it analyzes for interaction effects in non-parametric repeated measures data, such as likert data in a within-subjects experiment.

I also collected qualitative data through rater talk-aloud's as they read through different help requests, and discussions with help seekers at the end of the testing session. Qualitative data was analyzed using inductive coding methods. To better understand why raters evaluated help requests in a certain way, I coded for positive and negative reasoning in their talk-aloud's. To better understand help seeker confidence and general experience, I coded for expressed challenges as well as positive and negative impressions of tool usage.

5.7 Findings

Results show that help requests written with the tool are generally higher quality, help seekers can perform introductory help seeking skills after the tool is removed, and that help seekers report being likely to send help requests written with the tool.

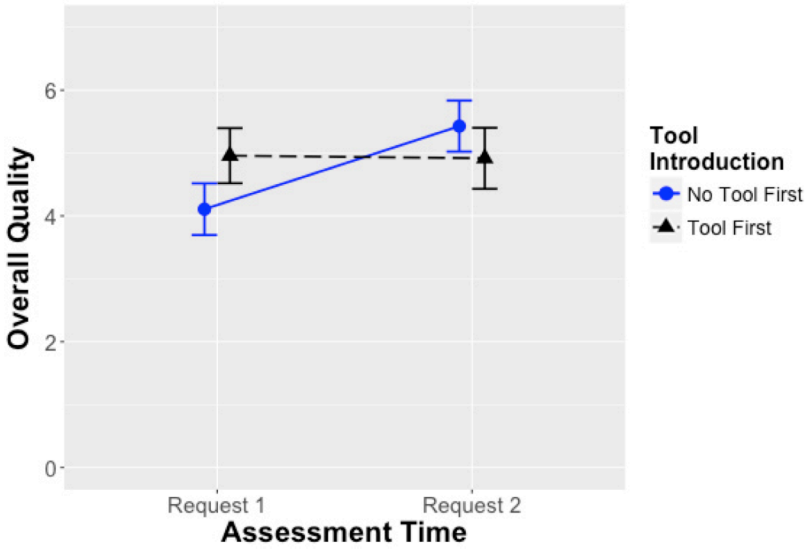

Figure 10: Help requests written using IntroAssist are rated as significantly higher quality (p<.05).

5.7.1 Impact on Quality

I find that help requests written with the tool are higher quality (Hypothesis 1). A two-way analysis of variance for non-parametric repeated measures data was conducted on the influence of two binary independent variables (Tool Introduction, Assessment Time) on the overall quality of the help request, measured on a 7-point likert scale averaged between the two expert raters. This analysis revealed a main effect of assessment time whereby quality was higher at the second assessment time ($F(1,24)=14.53$, $p<.005$). However, as can be seen in Figure 10, there is a significant interaction effect between Tool Introduction and Assessment Time ($F(1,24)=14.45$, $p<.005$), which shows that help requests written with the tool during the first assessment time (Figure 10, Tool First-Request 1) were higher quality than those written without the tool (Figure 10, No Tool First-Request 1) ($M_{ToolFirst}$=4. 96, $M_{NoToolFirst}$=4.11, p<.05). There was no significant difference in quality between help requests written after exposure to the tool (Figure 10, Tool

First-Request 2) and help requests written with the tool during the second assessment time (Figure 10, No Tool First-Request 2) ($M_{ToolFirst}$=4.92, $M_{NoToolFirst}$=5.43, p>.05). This interaction effect allows us to check that the increase in quality is due to the introduction of the tool rather than improved performance from writing another help request.

Even though Rater 1 and 2 highly agreed that help requests written with the tool were better, they disagreed on the reasons why. Based on both qualitative and statistical data, Rater 1 found that help requests written with the tool were better because they had a clearer introduction and indicated better reputability, while Rater 2 found that help requests written with the tool were better because they had a clearer ask, and were more polite, personalized, and succinct. Rater 1 expressed, *"Reputation always wins out. I could get an email with a perfect ask, but if I don't know who it is then I won't respond."* For instance, in Figure 11, the help request written without the tool does not include the help seeker's name (Figure 11, left), while the request written by the same person with the tool includes the help seeker's name and more succinctly explains her background (Figure 11, right). Rater 2 did not find significant differences in introduction and reputability, but did notice differences with respect to clarity of ask, politeness, personalization, and succinctness. For instance, Rater 2 explained that the help request written with the tool in Figure 11 was better because it had a clearer ask: *"This one, they clearly said what they needed from me."* The help request written with the tool specifically asks to schedule a meeting (Figure 11, right), while the help request written without the tool (Figure 11, left) just says that they are "interested in learning more."

Without Tool	With Tool
Hello, We are a group of undergraduate students from Midwest University working on a project to address adolescent depression through Design Organization this summer. As a bit of background information, Design Organization, also called D.O., is a program for college students that aims to make a lasting social impact through student-run design projects. D.O. is located at several universities throughout the country and is active throughout both the academic year and the summer. This summer, our group's project is to address the problem of depression and suicide in teenagers. More specifically, we are focused on the [City], [State] community, as there have been several suicides by high school students in the area in recent years. We are working with doctors at the [City] hospital, mental health professionals, and community members. One of our areas of interest in mental health training and education in high schools. From both our own experiences and research, we all feel that school mental health curriculum is often inadequate, and there is a major stigma surrounding mental illness that is what leaves problems hidden until it's too late. From our research we discovered [your organization], and are interested in learning more about your organization and its education and training in schools. Thank you. - D.O. members [First Name], [First Name], [First Name], and [First Name]	Hi, My name is [First Name] and I'm a student at Midwest University. This summer I'm working with three other students through Design Organization, which is a student organization that aims to address social problems and make a lasting impact through design. Our goal is to address depression and suicide, specifically in the [City] community. We are working closely with mental health professionals at the [City] hospital and community members. From our preliminary meetings we have realized that academic stress is often correlated to mental illness, and are considering this as the focus for our project. We think [your organization] would be a great resource as it deals with students who are a similar age and likely under the same experiencing similar problems. We would like to meet in person if possible to discuss mental health in teens and young adults. Would it be possible to schedule a group meeting with a professional from [your organization]? Thank you. - [First and Last Name] and the D.O. team

Figure 11: Expert raters found the help requests written *with* the tool (e.g. Right) to be higher quality than those written *without* the tool (e.g. Left).

Overall, I find that using the tool positively impacts the overall quality of the help request. But it is unclear why a request may be better as raters preferred requests for different reasons, suggesting that different people value different content in evaluating help requests.

5.7.2 Performance After Tool Removal

I also find that help seekers are able to perform introductory help seeking skills after the tool is removed (Hypothesis 2). To better understand what is driving the interaction between

Assessment Time and Tool Introduction, I perform contrast tests. I find that when the tool was introduced at the second assessment time (Figure 10, No Tool First), there is a significant increase in quality from Request 1 to Request 2 ($p<.05$). But, there was no significant difference in overall quality when the tool was introduced during the first assessment time (Figure 10, Tool First) ($p>.05$), suggesting that participants are able to continue performing introductory help seeking skills after the tool is removed.

Help seeker participants expressed that it was useful to have access to a tool that could provide communication instruction, especially when they did not have easy access to someone, like a parent, instructor, or supervisor, who had strong communication skills and could read over a draft of an email on demand.

5.7.3 Impact on Confidence

I find that help seekers were not more confident in the quality of help requests written with the tool, but did report being more likely to send help requests written with and after exposure to the tool. This provides partial support for Hypothesis 3. A two-way analysis of variance for non-parametric repeated measures data was conducted on the influence of two binary independent variables (Tool Introduction, Assessment Time) on the help seeker's report of being likely to send the help request, measured by a 7-point likert scale. There was a main effect of Assessment Time ($F(1,23)=6.07$, $p<.05$) and Tool Introduction ($F(1,23)=11.48$, $p<.005$), where being likely to send was reported as higher at the second assessment time. However, as can be seen in Figure 11, there is a significant interaction effect between Tool Introduction and Assessment Time ($F(1,23)=11.86$, $p<.05$). Participants who used the tool during the first Assessment Time (Figure

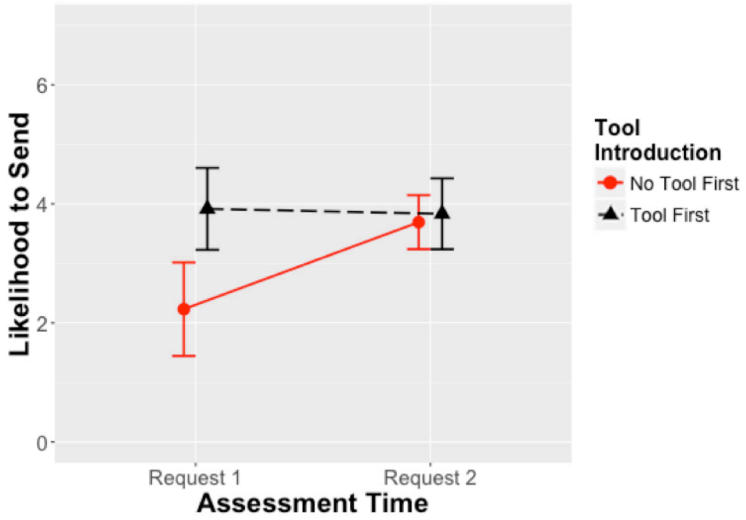

Figure 12: Help seekers are more likely to report being likely to send help requests written with IntroAssist.

12, Tool First-Request 1) reported being more likely to send their help request than those who did not use the tool (Figure 12, No Tool First-Request 1) ($M_{ToolFirst}$=3.92, $M_{NoToolFirst}$=2.23, p<.05). There was no significant difference in report of being likely to send after exposure to the tool (Figure 12, Tool First-Request 2) when using the tool at T2 (Figure 12, No Tool First-Request 2) ($M_{ToolFirst}$=3.83, $M_{NoToolFirst}$=3.69, p>.05).

Using a contrast test, I find that when the tool was introduced at the second Assessment Time (Figure 12, No Tool First), there is a significant increase in report of being likely to send from Request 1 to Request 2 (p<.05). There was no significant difference in report of being likely to send when the tool was introduced during the first assessment time (Figure 12, Tool First) (p>.05), suggesting that participants have retained confidence in sending the help request even after the tool is removed.

Novices expressed that having the tool helped them structure the email, identify what to include, and come up with the wording more easily. Some participants even sent the help

requests written with the tool during the experimental session. For example, one participant explained how tagging his own email helped him make sure that he included all the needed information, *"Forcing someone to [tag their own email] makes sure they have that content in their email, which is useful…I just found it very useful to like force myself to like, does it actually have a goal?"*

When asked to write a help request without using the tool, after having used the tool earlier, one participant explained, *"I had a harder time coming up with words because I didn't have examples. It was taking me longer to actually form words…I definitely would not send the one I just wrote [without the tool]. I felt like the first one was more structured, and I felt more confident with that one."*

In future versions of this tool, tagging one's own email would help populate the pool of tagged examples from which peers can take inspiration. Even though tagging may take extra time, participants expressed that it helped them reflect on the quality of their writing and double-check that they included important content.

5.7.4 Impression of IntroAssist

IntroAssist was received positively with 86% of participants expressing that they found the tool "Very Useful" to "Extremely Useful, " and "Very Likely" to "Extremely" likely to recommend it to a friend. Some participants continued to voluntarily use the tool after the testing session as well, and multiple participants asked if the tool would be commercialized and if they could share it with friends. Throughout the development of IntroAssist, University career advisors expressed high interested and asked if they could use the tool as part of their undergraduate curriculum to

help students write cover letters to search for jobs and internships. Interest from people outside of the entrepreneurship space highlights the broader applicability of this tool for supporting other types of requests, such as employment emails, grant writing, and publicity material.

The few participants who expressed dislike of IntroAssist explained that they already felt confident in their ability to write help requests and did not think this tool would help them or others. One participant who rated low usefulness of the tool explained *"I guess I'm just not intimidated writing emails."* In this particular case, this participant's confidence in her ability was not matched by a high quality evaluation by either rater, suggesting that help seekers may not have an accurate evaluation of their own help-seeking skills.

5.8 Limitations and Future Work

I also acknowledge limitations with this study. For instance, the tool was tested in a specific entrepreneurial community. Future work would include deploying this tool to other contexts to test how different community-types, demographics, and structures influence tool usage. I explore how a package of features supports help request performance and confidence. A future lab study could be done to test each of these features individually and in combination to identify what specific benefits each feature provides. I also plan to perform a longer-term study to test more robust measures of learning, such as long-term skill retention and transfer to other help seeking contexts. Additionally, in the next version of the tool, I plan to recycle help requests written and tagged as peer examples for other help seekers. This recycling of examples was not tested in the current version in order to minimize problems with using an evolving design in an experimental setting. Now that I know this initial design produces positive effects on help seeking behavior, I

plan to deploy the tool for longer-term use in multiple professional communities, in order to test usability on a broader scale and identify what additional facilitation might be needed for successful adoption.

5.9 Discussion

Despite the increase in communication technologies meant to support the development of professional connections, many people still lack the necessary communication skills and confidence to access the resources they need. Like previous HCI scholars (Dillahunt, Bose, et al., 2016; Foong et al., 2017), I question the basic assumption that simply providing technologies to identify useful others is enough to encourage fruitful interactions. As a consequence, little work has focused on supporting the help seeker's ability and their willingness to reach out (Bamberger, 2009).

Unlike previous HCI literature where researchers apply cognitive apprenticeship to support one-on-one mentorship online (Suzuki et al., 2016), I study how these instructional methods can be designed into tool features in order to provide instruction when expert guidance is not readily available. To reiterate, IntroAssist supports *coaching*-like activity (providing advice as needed) through an expert-informed checklist of best practices and a suggested word limit, *modeling*-like activity (sharing one's work process so that others' can learn from them) by providing tagged peer examples, and *reflection* (having learners think over their actions to encourage retention and improved future behavior) by encouraging self-tagging of one's written help requests (Collins, 2006).

However, cognitive apprenticeship instruction is most effective if the learner believes the guidance provided is worth following (Collins, 2006). IntroAssist may work best in environments where checklist items and examples come from respected peers or are chosen by respected experts. Suggestions of how platform design can help identify which work examples to follow have been described in multiple online contexts, such as crowdfunding where higher funded projects are seen as more useful examples (Hui, Greenberg, et al., 2014), in fan-fiction (Campbell et al., 2015; Evans et al., 2017) and graphic design platforms (Marlow & Dabbish, 2014) where users identify content based on the number of likes or comments, and in crowd work support tools where crowd workers are provided "gold standard" examples of how to perform complex web search (Doroudi et al., 2016). Similar indications could be built into IntroAssist, such as through community leader tagging, to better encourage trust in instructional material.

I also recognize the opportunity for IntroAssist to enhance, rather than replace, supports provided by existing offline services. For instance, given initial interest by career counselors, IntroAssist might be particularly successful as a support tool deployed within existing career centers (e.g. university or city-based employment centers) or local professional communities (e.g. co-working spaces) where people look to leadership for suggesting supplemental resources that can be used at home when expert guidance is not readily available. The general design of IntroAssist could be applied to broader written communication contexts, such as seeking mentorship (Suzuki et al., 2016), funding (Hui, Greenberg, et al., 2014), and feedback (Foong et al., 2017), where communication requirements are more complex than expected (Foong et al., 2017).

6. DISCUSSION

Our findings add to long observed patterns of how the Internet has allowed traditionally solo activities to become more social. Over the years, researchers have described how workplace technologies, such as messaging systems, chat rooms, shared document editing tools, and online version control systems, are changing the way people work and learn with others.

6.1 Distributed Apprenticeship as an Emergent Theory

In order to support skill development in informal workplace communities, I find that people leverage a distributed approach to skill acquisition via *distributed apprenticeship*. Distributed apprenticeship describes how novice entrepreneurs are experiencing apprentice-like instruction by interacting with a distributed community of non-expert instructors across multiple platforms. For instance, novice entrepreneurs are able to consult examples of peer work (like modeling), seek feedback from extended networks (like coaching), explain process to maintain relationships (like articulation), and share reflection for community wellbeing (like reflection).

Distributed apprenticeship draws from a long history of learning theories that describe the role of external agents in the learning process. Broadly, Piaget's constructivism describes how people make meaning through their experiences (Piaget & Cook, 1952), while others expanded on this by emphasizing how social interactions provide opportunities to become aware of and practice skills (Brown et al., 1989; Lave & Wenger, 1991; Rogoff, 2003; Vygotsky & Cole, 1978). While these previous theories describe the role of social interactions in the learning process, I believe informal workplace communities present unique challenges to skill development not articulated in previous literature.

As today's workforce continues to shift towards non-traditional jobs outside corporations (Florida, 2004), the nature of work becomes increasingly distributed with heavy reliance on social technologies. Members of these informal workplace communities are now expected to develop skills where 1) there is often no dedicated instructor, 2) there are increased expectations of public transparency and social support, 3) there are thousands of examples of peer work to view and make sense of, and 4) the work is often more complex in that is non-routine, difficult to plan, and involves various sub-goals and diverse expertise. While more recent theories of learning in the digital age emphasize the role of networks as distributed structures of knowledge organization (Hollan et al., 2000; Siemens, 2014), they inadequately discuss how social expectations within these networks influence who performs instruction and how. An incomplete understanding of skill development and the stakeholders in this process limits our ability as HCI researchers to inform and evaluate platforms created to meet the changing professional development needs of an increasingly informal workplace.

In the contexts of makerspaces and crowdfunding communities, I find that social expectations of social support and transparency motivate people to provide advice, content, and explanations of their work, which serves as instructional material for others. This motivation to post additional content and help others in the community might stem from the types of people who participate in these types of communities, such as makers, who have been shown to exhibit values of social support (Toombs et al., 2015). Given that informal workplace communities increasingly exist outside corporate structures, it is also possible that the people drawn to these professions understand the need to build and join communities where people are motivated to support each other.

I also find that the public nature of performing work influences community expectations of the work process itself. For instance, because crowdfunding is publicized as a way to engage the "crowd" in entrepreneurship, supporters expect crowdfunders to explain their process and, in some cases, even allow them control over certain design decisions. This is heightened expectation of transparency motivates members of these informal workplace communities, who are non-expert instructors and who do not see themselves in an instructor role, to inadvertently perform instructional activities, like requesting novice entrepreneurs to articulate their work.

While I present distributed apprenticeship as an emergent theory, I emphasize that it is not meant to replace traditional forms of apprenticeship, but rather extend it to a new growing area of professional development. In many ways, traditional apprenticeship is still considered a gold standard of instruction *if* novices are able to find someone who has the right skills and is motivated to provide long-term guidance. However, this is becoming more challenging as the knowledge required for most modern day jobs is rapidly evolving and requiring increasingly diverse skillsets (Pew Research Center, 2016). Therefore, the chances of finding someone who has the specific set of interests and expertise, as well as time, to be a mentor is slim, causing people to turn to more distributed sources of instruction. To advance this emergent theory, we must continue to study how distributed forms of instruction might supplement gaps in more traditional educational models, such as formal schooling.

6.2 Implications for Skill Development in HCI

Through this work, I expand how theories of informal learning are instantiated in online contexts and compare and contrast these findings with other models of learning in HCI. The growing

amount of work on leveraging social technologies for learning in online communities has primarily focused on describing modeling and feedback in single platforms, like design platforms (Marlow & Dabbish, 2014), fan-fiction platforms (Campbell et al., 2015; Evans et al., 2017; Fiesler et al., 2017), university project-based learning platforms (Rees Lewis et al., 2015), and MOOCS (C. Kulkarni et al., 2013). I argue that a distributed approach to skill development is particularly important for developing skills where each project needs a different set of instructions from different sources.

Previous frameworks describing how novices learn in online communities have been discussed in the context of newcomer socialization (Kraut & Resnick, 2012) and moving from peripheral to central participation (Preece & Shneiderman, 2009). Kraut and Resnick (2012) describe how newcomers "must struggle to make sense of how to contribute on their own," and argue that online communities generally use individualized socialization tactics, where newcomers are provided limited guidance by more senior members of the community (Kraut & Resnick, 2012). Similarly, novice entrepreneurs also face difficulties finding long-term mentors who could guide them through the work process, and find that they too had to "learn-on-the-job" with little guidance. I build on research of newcomer socialization in online communities by describing how novices combine instruction from different community stakeholders to mimic hard-to-find expert instructional guidance. With a better understanding of how people combine distributed instruction, we can design support tools for informal workplace communities that foster broader opportunities for skill development.

Others describe learning in online communities from a "Reader-to-Leader" perspective where novices become increasingly involved in online communities by moving from marginally

contributing to leading online collaborations (Preece & Shneiderman, 2009). Similarly, in my data I encountered people who worked on friends' entrepreneurial projects before developing their own. Supporting these opportunities can be inspired by related work performed by Morris et al. (2017), which describes a system to support microtasking in crowd work as a potential initial activity for novice workers to perform skills in an authentic environment before committing to full-scale tasks (Morris et al., 2017). Most recently, Kickstarter launched a new initiative called "Kickstarter Commissions" which "invites backers into your creative process." Inviting others to provide input and expertise into one's campaigns is one way official crowdfunding platforms are initiating opportunities for online situated learning opportunities (Lave & Wenger, 1991), like in the "reader-to-leader" framework. Further work needs to be done to better understand how these peripheral opportunities to participate are initiated in informal workplace contexts, how relationships are managed over the course of a project, what specific aspects about these interactions foster skill development, and the role of technology in these activities.

I further theoretical understanding of instruction in online communities by describing how novices leverage social technologies to develop complex work skills. While these technologies allow people to more easily communicate with geographically distributed people, they also introduce a new host of problems, such as challenges of coordination (Chesbrough, 2003), expert identification (Yarosh et al., 2012; J. Zhang & Ackerman, 2005), and establishment of trust (Kim et al., 2017; Toma, 2010). These findings provide implications for how community design and technologies can be improved to provide greater opportunity for skill development in informal workplace communities.

These gaps motivated my final study in which I applied cognitive apprenticeship instructional methods (Collins, 2006) to explore how the design of a web-based tool could facilitate professional connections through the writing of introductory help requests. Similar supports could be designed to support distributed apprenticeship in other informal workplace contexts like crowdwork (Gray et al., 2016), online creative communities (Campbell et al., 2015; Evans et al., 2017; Fiesler et al., 2017; Marlow & Dabbish, 2014), freelance crowdsourcing marketplaces (Hannák et al., 2017; Parigi & Ma, 2016; Suzuki et al., 2016), and MOOCS (Dillahunt, Ng, Fiesta, & Wang, 2016; C. Kulkarni et al., 2013). To describe how distributed apprenticeship applies to other online workplace contexts, I describe how it could support skill development in the context of crowd work.

6.2.1 Implications for Crowd Work

Crowd work—where distributed workers perform tasks posted online by requestors in exchange for financial compensation—is considered one of the most promising opportunities to support social mobility on a global scale through on-demand employment (Kittur et al., 2013). I align this work with crowd work literature to identify ways to better support the worker, such as promoting ethical employment practices (Bederson & Quinn, 2011; Irani & Silberman, 2013; Salehi et al., 2015), career growth (Kittur et al., 2013) and skill development (Suzuki et al., 2016). I believe distributed apprenticeship can provide a useful framework to identify where support tools are succeeding and lacking in supporting instruction within online workplace communities, like crowd work.

Despite rich online interactions between members (Gray et al., 2016), crowd workers typically work without in-person contact with peers, making crowdwork an ideal context to apply online socially-based instructional methods (Coetzee, Lim, Fox, Hartmann, & Hearst, 2015), like distributed apprenticeship. Unlike in entrepreneurship, the work of crowd work is requestor defined (not worker defined), and work tasks are typically less complex (e.g. transcribing an audio file) than those described in entrepreneurship (e.g. filming a publicity video). However, this often depends on who is performing the work and their set of expertise. As crowd work continues to advance and expand, the type of work being performed will continue to grow in complexity and new models of learning the complex skills will be needed.

In order to benefit from social learning opportunities, crowd workers describe connecting with peers via phone, online forums, chat, social media, and in person (Ding, Shih, & Gu, 2017; Gray et al., 2016). These social interactions allow crowd workers to develop relationships with people who have platform expertise (e.g. how to set up an account) and people with expertise on certain tasks (e.g. copy editing). By connecting with others in the community, people with more expertise can develop more stable careers as community managers, while novices can establish relationships with those who might point them towards promising jobs or tasks (Ding et al., 2017). For instance, crowd workers describe choosing tasks that allow them to practice skills, such as writing in English (Martin, O'Neill, Gupta, & Hanrahan, 2016). Others describe balancing choosing tasks that fall within their skillsets and tasks that allow them to try something new (Gupta, Martin, Hanrahan, & O'Neill, 2014).

While there has been much work to develop tools that support social learning in crowd work, distributed apprenticeship can provide a framework by which to identify gaps in

instruction. For instance, the method, *seek feedback from extended networks*, highlights the opportunity to seek feedback from a wide stakeholder network, including peers, domain experts, and supporters (in this case, requesters). Related work describes the benefits of pairing novices with dedicated experts (Suzuki et al., 2016), hiring people to be community managers (A. Kulkarni et al., 2012), and supporting peer-to-peer connections (Dow, Kulkarni, Klemmer, & Hartmann, 2012; Whiting et al., 2016), to encourage coaching activity. Similar work could also be done to facilitate timely feedback from task requestors, which would allow another avenue to develop positive relationships between workers and requesters, a key issue in supporting healthier crowd work environments (Irani & Silberman, 2013; Martin et al., 2016).

The instructional mechanism of *share reflection to support community wellbeing* highlights an opportunity to develop tools that motivate reflection as part of the work process. While previous studies (Dow et al., 2012; Zhu, Dow, Kraut, & Kittur, 2014) describes how crowd work platforms can require reflection activity to participate, I suggest designing communities in a way that encourage crowd workers to reflect as motivated by social expectations. For instance, Kulkarni et al. describe a system where they hire managers, who are particularly experienced members in the community, to recruit workers and perform coaching responsibilities like giving feedback and managing conflict (A. Kulkarni et al., 2012). Crowdwork platforms could motivate people to post reflections for the benefit of others' in order to gain status and the opportunity to become managers, who are paid more and have greater career stability. *Consulting posted examples of peer work* would also help novice crowd workers develop skills through the apprenticeship method of modeling. While posting examples of work poses problems with privacy, certain requestors and workers might be interested in volunteering

to share their work in order to benefit novices in the community, or at least those working on the same task.

In addition to crowd work communities, distributed apprenticeship can be applied to other related online workplace communities, such as gig economy platforms where people develop skills through requests for crowdsourced freelance work (Parigi & Ma, 2016; Suzuki et al., 2016), creative work platforms where amateur designers and artists develop skills by posting work and receiving feedback (Campbell et al., 2015; Evans et al., 2017; Fiesler et al., 2017), and even MOOCS where an increasing number of people are taking project-based courses to learn how to develop their own products and services ("Design Kit: The Course for Human-Centered Design," n.d.). Using the instructional framework of distributed apprenticeship to analyze existing work in these informal workplace contexts helps to identify particular instances where skill acquisition is most likely to occur and where it needs support.

6.3 Implications for Skill Development in Entrepreneurship

The public nature of co-located and distributed informal entrepreneurial communities, like in makerspaces and crowdfunding, has changed how entrepreneurship is performed. I find that the addition of these platforms provides a repository of peer work to take inspiration from, a large network from which to seek feedback, and community of dedicated peers and supporters who drive opportunities for articulation and reflection-like activity. Unlike previously studied entrepreneurial communities, the transparent nature of entrepreneurial work in informal workplace communities influences how members acquire professional skills.

While entrepreneurship researchers have studied the types of skills needed, few have studied *how* entrepreneurs acquire these skills (Cope, 2005). The overarching skills needed to perform entrepreneurship typically refer to the cognitive processes by which entrepreneurs transform their experiences into different forms of knowledge and action (Baron, 1998; Kolb, 1984). For instance, entrepreneurship researchers have argued that inconsistencies between individuals' existing knowledge (Ardichvili, Cardozo, & Ray, 2003; Shane, 2003) and their behavior are rooted in cognition, which could explain why some people are able to recognize and exploit venture opportunities, while others with similar backgrounds and experiences do not (Corbett, 2005; Shane, 2003). The majority of literature has focused on knowledge sources, such as social networks, first-hand experience, and formal schooling (Sexton, Upton, Wacholtz, & McDougall, 1997; Slotte-Kock & Coviello, 2010). While formal approaches to entrepreneurial skill acquisition, such as business roundtables, seminars, videos, and books (Sexton et al., 1997) are still heavily used ("Common Teaching Materials," 2014), informal sources like one's position in a social network and first-hand experience, have been argued to be more effective (Kauffman Foundation, 2008).

More recently, entrepreneurship researchers have focused on understanding the experiences that entrepreneurs endure as a source of entrepreneurship knowledge (Chen et al., 1998; Corbett, 2005; Kauffman Foundation, 2008). This experiential learning perspective highlights the importance of trial-and-error, learning from failure, and authentic environments (Cope & Watts, 2000; Deakins & Freel, 1998; St-Jean & Audet, 2012). I expand the literature on understanding entrepreneurial experiences by studying the process of apprenticeship in

entrepreneurship communities where novices leverage social technologies to overcome challenges with finding consistent mentorship.

I find that novice entrepreneurs who have never launched an entrepreneurial venture before are leveraging social technologies in makerspaces to develop connections with mentors, and performing crowdfunding as an introductory activity to larger scale entrepreneurship activity (Gerber & Hui, 2013; Hui, Greenberg, et al., 2014). Crowdfunding entrepreneurs often describe their relationship with peers as more supportive than competitive (Hui, Greenberg, et al., 2014). While entrepreneurship does involve collaborating with teammates and other firms, previous literature emphasizes that entrepreneurs must maintain information asymmetry to maintain competitive advantage for a greater likelihood of opportunity exploitation (Shane, 2003). This behavior is different from much of observed behavior in the makerspace and crowdfunding communities that I studied where people post their work publicly online, and volunteer to give advice and feedback to each other (Hui, Greenberg, et al., 2014). Such cooperative competition has been observed in artisan entrepreneurial communities as well, like Etsy, where people are motivated to provide support to other members despite competing for the same customers (Kuhn & Galloway, 2015).

7. LIMITATIONS

All the studies were performed with novice entrepreneurs in US-based in environments. The social practices, access to technology, and ways in which people use technology may be primarily descriptive of the geographic and socio-economic populations studied. For instance, previous research has shown that crowdfunding users are not particularly diverse (Rhue & Clark, 2016), which suggests that further work must be done to understand the barriers and challenges to using these technologies. Similarly, people who are able to participate in the makerspace that we studied may have been limited to the demographics of the local neighborhood. Furthermore, while we chose a primarily qualitative approach to understand people's behavior, additional studies with different entrepreneurial populations combined with quantitative approaches, like surveys, would be useful at identifying broader patterns of behavior.

8. CONCLUSION

Informal entrepreneurial communities have created new opportunities for apprentice-like instruction in the absence of dedicated expert guidance. Novice entrepreneurs who generally face higher levels of uncertainty and are in most need of expert guidance, yet have the least access to social and pedagogical support, have turned to co-located and distributed informal entrepreneurial communities to develop skills. These communities have opened up new opportunities to find and view others' work, seek advice from an extended network, and reflect on one's own work to inform future practice. As social technologies make it easier to communicate and publicly share one's work, leveraging the wealth of information and networks in informal entrepreneurial communities to perform professional skill development has become increasingly complex. This work seeks to investigate how informal entrepreneurial communities support new opportunities for apprenticeship, and how technologies can be designed to better facilitate these interactions. I summarize my contributions in Appendix A and below.

Understanding of apprenticeship in a co-located informal entrepreneurial community

The first contribution of this work is an understanding of how co-located informal entrepreneurial communities foster opportunities for apprenticeship in the absence of dedicated expert guidance (Chapter 3). Through a five-week long participant observation of an entrepreneurial makerspace and 22 in-depth semi-structure interviews, I identified how the social structure and social technologies used in the makerspace supported opportunities for the apprenticeship mechanisms of modeling, scaffolding, coaching, and exploration. The findings highlight that apprenticeship in co-located communities relies on supporting distributed forms of

communication and project sharing. While the in-person nature of the co-located community allowed for traditional forms of apprenticeship, the use of social technologies allowed members to interact outside of the space, providing another more continuous channel for relationship development and knowledge sharing among all members.

Understanding of apprenticeship in a distributed informal entrepreneurial community

The second contribution is an understanding of how distributed informal entrepreneurial communities foster opportunities for apprenticeship in the absence of dedicated expert guidance (Chapter 4). Through interviews with 62 crowdfunding entrepreneurs, I identified mechanisms for how social technologies supported a distributed form of apprenticeship through consulting examples of peer work, seeking feedback from extended networks, expressing process to maintain reputation, and sharing reflection to support community wellbeing. These findings highlight how social technologies facilitated social expectations of these informal workplace communities, such as developing strong consumer relationships and providing knowledge back to peers. These increased interactions in turn supported greater opportunities for apprenticeship.

Emergent theory of Distributed Apprenticeship

The third contribution is an emergent theory of distributed apprenticeship. This framework was built out of the previously described study, and describes how distributed apprenticeship is unique from previously described traditional and cognitive apprenticeship. Unlike traditional and cognitive apprenticeship, which is typically carried out by an expert instructor in a centralized form (e.g. classroom), distributed apprenticeship is led by a distributed network of non-expert instructors (e.g. crowdfunding community). Furthermore, even though cognitive apprenticeship

scales traditional apprenticeship to larger classroom-sized groups, distributed apprenticeship describes how these instructional mechanisms can be scaled to distributed communities of hundreds or thousands of people.

Design and evaluation of IntroAssist system

The fourth contribution of this work is the design and evaluation of IntroAssist, a system I designed and developed to help novice entrepreneurs 1) write better introductory complex help requests and 2) increase their confidence in sending these requests (Chapter 5). I followed a mixed-methods design research approach involving exploratory interviews with both novice entrepreneurs and expert responders to inform ideation and prototyping. IntroAssist scaffolds writing help requests by providing a checklist of best practices and tagged examples of community help-requests. Two raters evaluated the quality of help requests written using IntroAssist, and found that it had significant effects on quality. An analysis of novices' survey responses after using IntroAssist showed that they were significantly more likely to send help requests if using the tool.

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APPENDIX A: DISSERTATION CONTRIBUTIONS

Contribution	Methods	Participants	Relevant Data Used
Understanding of apprenticeship in a *co-located* informal entrepreneurial community	In-depth semi-structured interviews	22 participants	Transcripts of interviews
	Participatory Observations	Community of 103 people	Observation notes
Understanding of apprenticeship in a *distributed* informal entrepreneurial community	In-depth semi-structured interviews	62 participants	Transcripts of interviews
Emergent theoretical framework of Distributed Apprenticeship			
Design and Evaluation of IntroAssist system	Semi-structured interviews with novice entrepreneurs	9 participants	Interview notes
	Workshop with novice entrepreneurs	5 participants	Notes and worksheets from ideation session
	Semi-structured interviews with expert help responders	7 participants	Transcripts of interviews
	Iterative cycles of ideation and prototype testing	Informal feedback from over 30 participants over time	Feedback Notes
	Within-subjects experimental study with novice entrepreneurs	26 participants	Written help requests
	Survey evaluating novices' confidence and impressions of tool	26 participants	Survey responses to open-ended questions; ANOVA of survey responses
	Expert rating of help requests	2 raters	Recorded talk-aloud's; ANOVA of request ratings