PROTO-INSTITUTIONALIZATION AS A COMPLEX SOCIO-TECHNICAL PROCESS: THE EMERGENCE OF DIVERSITY PRACTICS IN COMPUTER SCIENCE EDUCATION

by

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ABSTRACT

DANIEL JONATHAN DAVIS. Proto-institutionalization as a complex socio-technical process: The emergence of computer science education diversity initiatives. (Under the direction of BETH A RUBIN)

Extant scholarship in organizational science explains the conditions under which organizational actors adopt established institutional practices. Organizational scientists have been less successful in explaining the *origins* of institutional practices; addressing that lacunae is the focus of my research. Specifically, this study examines the emergence of novel institutional practices or the process of proto-institutionalization as a complex social process that occurs both through face-to-face and virtual interaction among numerous, disparate organizational actors. Accordingly, I introduce a novel theoretical construct – the digital field – to explain how information technologies facilitate proto-institutionalization. To map the digital field, I use a web crawler to collect a sample of websites from the digital field of computer science education. Social network analysis examines the structure of the digital field. To contextualize the findings from the network analysis, I conduct interviews with organizational leaders of DiverseCS, a non-profit organization that aims to increase the representation of women and racial/ethnic minorities in computer science education. I find that organizational leaders pursue three strategies of action to enable the emergence of proto-institutions in a digital context: 1) building a coherent organizational identity, 2) engaging in network brokerage, and 3) constructing organizational narratives. Together, a mixed methods approach provides a lens to understand the macro-level and micro-level connections and complexity in a

digital field during proto-institutionalization. This study, therefore, holds important implications both for organizational science and also management practitioners.

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CHAPTER 1: INTRODUCTION

Extant scholarship in the organizational sciences explains how organizational actors adopt established institutional practices and how such practices diffuse throughout organizational populations (e.g. Dobbin et al., 2011; Guler et al., 2002). Nevertheless, the origins of institutional practices have been ambiguous and a point of contention among institutional scholars for the past several decades (Huegens & Lander, 2009). The difficulty in answering questions surrounding institutional genesis results from institutional theory's inability to explain organizational actions that deviate from institutional conformity (Greenwood et al., 2014). To resolve this quandary, a growing stream of research has begun to address the origins of institutions through several theoretical propositions that specify the process of proto-institutionalization (Powell et al., 2014). Proto-institutionalization refers to the creation of novel institutional practices, where actors combine various systems of meaning (i.e. discourse, symbols, and myths) from disparate institutional fields to create new social practices (Powell et al., 2016). Organizational action, though, often occurs in a virtual context. Although proto-institutionalization theory acknowledges the important role of information technology during institutional genesis (see Powell et al., 2014), no theoretical framework currently explains how individuals use information technology to innovate proto-institutions. Therefore, to address this theoretical gap in the extant literature, this research explores proto-institutionalization in a digital milieu.

Organizational actors increasingly turn to digital forms of communication to engage with others regarding shared societal or organizational issues. This engagement contributes to the emergence of virtual spaces where collaboration and contestation over

field-level action occur among a diverse set of actors (Faraj et al., 2011; Ince et al., 2017), facilitating institutional innovation (Powell et al., 2016). Moreover, digitally mediated interaction affords opportunities for radical or non-linear organizing processes. For instance, a single blog entry or social media post may resonate with millions of individuals and engender widespread institutional change, as in the formation of the Black Lives Matter social movement or the 2010 Arab Spring revolutions. the structure of information on the World Wide Web and the actions that it affords greatly alters interactional patterns among organizational actors, facilitating proto-institutionalization.

From this perspective, websites and their connections via hyperlinks become important socio-technical structures that reflect the relational configurations of the field surrounding a particular issue (Powell et al., 2016). Websites reflect pertinent relational information, as hyperlinks offer insight into the decisions by organizational members to recognize other actors (Powell et al., 2016). I contend that hyperlink networks uniquely structure interaction among actors and shape the process of proto-institutionalization. I refer to these hyperlink networks as *digital fields* and introduce the construct of the digital field to the organizational sciences. Specifically, the digital field represents the shared cognitive understandings of information among field members and the relative positions of information brokers surrounding a particular societal or organizational issue. For these reasons, any theoretical framework of proto-institutionalization must take the digital field into account as a central explanatory mechanism that explains how technology shapes how actors influence and interact with emergent institutional practices.

Exploring the relational structure of the digital field is crucial in order to shed light onto the processes that underlie how organizations engage in proto-

institutionalization. I adopt a complexity science lens to understand the structure of the digital field. As a paradigm of change (Kauffman, 1993, 1995; Boisot & McKelvey, 2010), complexity science provides the theoretical link between the interaction that occurs among actors and the emergence of field-level action within the digital field. The central thesis of complexity science contends that as multiple, autonomous actors interact, absent of a central authority, higher level structures emerge that are qualitatively unique from the preceding constituent parts (Miller & Page, 2007). From a complexity perspective, a complex network structure makes emergent action possible (Miller & Page, 2007). Hence, complexity suggests the possibility of both moderate and radical organizational action due to how information technology structures interaction and lowers the cost of transactions. There are various definitions of complexity (see Miller & Page, 2007) and the one I adopt is Barabási and Albert's (1999) definition due to their emphasis on network structure. Barabási and Albert (1999) explain complexity within a network through several measures – degree distribution, average path length, and clustering coefficient – that together describe a dense, inter-connected network structure. Collectively, these properties of the network give rise to complex actions.

Network structure alone fails to account for how the digital field shapes the process of proto-institutionalization. Drawing on theories of structuration (Jones & Karsten, 2008), I propose that the digital field structures action through the combination of the technical features of the system, its use by individuals, and the organizational context where interaction occurs (Gal et al., 2014; Orlikowski, 2007). Although the technical features of a system are similar, actors differentially construct meaning through its use (Leonardi, 2011). For example, Thelwall (2006) claims that are no universal

theories of linking with respect to hyperlinks to explain why individuals create links from their website to another one. For these reasons, action within the digital field must be understood from the perspective of those who enact and sustain it. Moreover, the structure of the digital field provides unique opportunities for non-linear processes, such as the possibility of a single message on social media becoming the banner of an emergent social movement or the ability of actors to use an organizational website to promote innovation among hundreds of other organizations. Thus, the use of information technology, such as hyperlinks, search engines, and social media provides actors with opportunities for unique and radical patterns of action (Orlikowski, 2007, Zammuto et al., 2007). Nevertheless, understanding how interaction occurs in the digital field is an open empirical question.

The actions of organizational leaders provide further insight into how the digital field structures proto-institutionalization. Specifically, from an institutional perspective, successful leaders maintain internal organizational consistency during periods of transition or change, but also guide institutional change to achieve organizational goals (Kraatz & Moore, 2002; Tengblad, 2004). Since collaboration is vital during proto-institutionalization (Powell et al., 2014), leadership efforts that facilitate coordination are likely critical mechanisms that facilitate the emergence of novel institutional practices. Complexity leadership theory complements institutional leadership theory by specifying that adaptive organizational outcomes (i.e. learning, survival, and innovation) are the result of interactions among numerous, diverse agents (Marion & Uhl-Bien, 2001). The leader's role is to make sense of radical organizational changes and to negotiate the exchange of resources across social networks, uniting individuals together who can create

change (Plowman et al., 2007a). In this manner, network enhancing actions and discursive strategies are crucial for the leader's efforts of proto-institutionalization.

The purpose of this study is to explain the organizational processes underlying the formation of the digital field that facilitates proto-institutionalization and the mechanisms by which organizational leaders enable the emergence of proto-institutions. Specifically, I argue that institutional theory must incorporate information technology into its theoretical framework as an explanatory mechanism – the digital field – to understand the process of proto-institutionalization.

I situate this study among the collaborative efforts of numerous, disparate organizational actors that seek to ameliorate the lack of diversity in computer science education. This lack of diversity refers to the underrepresentation of women and racial/ethnic minorities (Bybee, 2010). This context is ideal for this study because despite fervent efforts by educators, business leaders, and policy makers, there are currently no universally accepted institutional practices that address issues of diversity in computer science education. As such, actors continue to collaborate, often relying on digital interaction, to innovate proto-institutions. I employ a sequential explanatory mixed methods design, where qualitative data contextualizes, explains, and makes sense of quantitative data (Creswell, 2003). Specifically, I use web crawler technology to identify the digital field pertaining to diversity issues in computer science education. I then use network analysis to demonstrate that the digital field adheres to a complex network structure, suggesting how digital action may exhibit dynamic properties (Wang et al., 2011). To better understand the action that underlies the structure of the digital field and how proto-institutionalization occurs within the digital field, I conduct in-depth

interviews with twenty members of an organization located within the digital field. I integrate these findings to create a theoretical framework that explains proto-institutionalization as a result of face-to-face and virtual interaction.

Scholars of research methods contend that mixed methods designs can be difficult for the researcher to implement (Yanow & Ybema, 2011); taking the recommendations of these scholars, I offer a caveat for this study. Due to the exploratory nature of this study and the lack of theory surrounding proto-institutionalization, this study does not test theoretical derivations; therefore, I do not include hypotheses. I do, however, propose several research questions that I address through network analysis and grounded theory methodology. As such, this study illustrates both structure and agency that characterize digital fields, making contributions to both organizational science and information systems scholarship.

This study makes several contributions to the organizational science literature. Moving beyond mechanisms of stability, recent neo-institutional scholarship seeks to address field-level dynamics, such as field formation or the genesis of institutional practices (e.g. Powell et al., 2016; Leibel et al., 2018). This study contributes to this effort by articulating a theoretical framework that introduces the digital field as a complex socio-technical artifact and the central theoretical mechanism underlying proto-institutionalization. Complexity science's focus on emergence and mechanisms of change complement neo-institutional theory and offer an explanation of radical, non-linear institutional change. Although previous studies note the occurrence of radical change (Greenwood & Hinings, 1996), complexity science is appropriate to explain the transition from one state to a qualitatively different state (Miller & Page, 2007; Kauffman, 1995),

such as the emergence of novel institutional practices (Lawrence et al., 2002). This study takes the first step in this direction by documenting the complex network structure of the digital field, suggesting that the use and accessibility of information makes possible radical institutional change.

This study also contributes to organizational theory scholarship by addressing previous calls to consider how information technology influences processes of organizing (Zammuto et al., 2007). From this perspective, organizational action occurs at the interface of the digital field and the organizational field, as a duality between the virtual and the physical. For example, the decision to hyperlink amplifies information, which then alters face-to-face collaborative efforts. While previous studies document the structure of hyperlink networks in an organizational context (e.g. Powell et al., 2016), this study describes the motivations to engage online and digital resources and how their use influences action, examining both the structure and agency within the digital field.

This study further develops Selznick's (1957) theory of institutional leadership to incorporate the radical institutional change associated with proto-institutionalization. Although, institutional leadership has been a dormant area of research for some time, this study contends that proto-institutionalization cannot occur without leaders enabling emergent social practices. I, therefore, bring leadership back into institutional analysis and management in general. Additionally, by drawing insights form complexity leadership theory and producing a theoretical model that is a synthesis of both institutional leadership theory and complexity leadership, I reinvigorate research on this other, non-traditional model of leadership (Avolio et al., 2009). This synthesis permits

further theorizing and prompts empirical studies to further explore social innovation and entrepreneurship through the lens of non-traditional leadership.

I make several methodological contributions through the use of network analysis techniques from the physics and computer science literatures. These techniques reveal how the network topology of organizational communities is complex. I also use a novel mixed methods design by using computational techniques to understand network topology and qualitative techniques to explain the social processes underlying the quantitative observations. In this manner, I balance the variety of stimuli with the variety of responses to investigate complex organizational processes (Boisot & McKelvey, 2010). This design allows me to highlight complex processes at multiple levels of analysis. I hope that future research will adopt similar innovative methods in order to elucidate complex phenomena.

By examining computer science education, the present study makes significant practical contributions, as observers refer to the lack of diversity in the STEM fields as an educational crisis (Anft, 2013). Attention from the *National Science Foundation* and commentary from political leaders' further underscore the importance of increasing diversity. Moreover, a growing literature in the organizational sciences finds that diversity among members of work teams fosters innovation and creativity (e.g. Yang & Konrad, 2011) that continues to be a primary export of the knowledge economy. Accordingly, I seek to address the contemporary diversity crisis in computer science education by offering a theoretical framework and empirical findings that foster recommendations to increase the efficacy of inter-organizational collaboration and efforts of leadership. The results of this study identify leadership actions that have been found to

contribute to social innovation. This study, therefore, not only offers potential paths to ameliorate the diversity crisis in higher education but can also address other complex and pressing social problems.

This research also informs research on various contemporary social problems, ranging from poverty to Vice President Joe Biden's Cancer Moonshot initiative. Specifically, the study of computer science education diversity practices contributes to previous studies of proto-institutionalization such as nutritional services in developing economies (Lawrence et al., 2002) and non-profit organizational performance metrics (Korff et al., 2015; Powell et al., 2014). Proto-institutionalization often occurs within the context of complex problems that, due to a high degree of interdependent parts, cannot be addressed by individual efforts or simple solutions. For instance, efforts to ameliorate poverty, climate change, healthcare disparities, among many other social problems, requires the collaboration of numerous and diverse organizational actors to innovate solutions. This study presents a theoretical model that can be applied in many different contexts. Leadership actions that enable the emergence of diversity practices are also likely to enable the emergence of policy solutions to address poverty and climate change. The results, therefore, impact a broad swath of institutional fields and can aid the numerous leaders attempting to converse and forge ties across diverse communities and enable those communities to innovate proto-institutions.

Following this introductory chapter, I propose the digital field as a central theoretical construct within neo-institutional theory. I contend that the digital field facilitates complex organizational actions. I then turn to a description of my research design, underscoring the need for a mixed methods approach to answer my research

questions. The fourth chapter presents findings. Finally, I offer a discussion of my results

and their theoretical implications, before offering concluding remarks and highlighting

avenues for further research.

CHAPTER 2: LITERATURE REVIEW

The complexity of proto-institutionalization

The following section highlights the theoretical junctures amongst proto-institutionalization theory, the literature regarding technology and organizing, and also the literature on leadership. Specifically, I highlight how social media and information technology shape complex processes of proto-institutionalization. I then turn attention to how organizational leaders construct conversational bridges and facilitate the creation of network ties to enable the emergence of proto-institutions. I draw upon the literature on complexity leadership; complex leaders enable the emergence of innovation by facilitating interaction among individuals within turbulent and ambiguous organizational environments (Marion & Uhl-Bien, 2001). Complexity leadership theory's focus on innovation is particularly appropriate for explaining proto-institutionalization. I therefore integrate institutional leadership theory and complexity leadership theory to address theoretical gaps in extant literature. Doing so requires viewing social institutions as resulting from complex social process and considering how information technology facilitates complexity.

While institutional theory explains the diffusion of *established* social practices (e.g. Dobbin et al, 2011), much less is known about the origins or the emergence of new institutional practices. Proto-institutionalization theory seeks to addresses this limitation. Proto-institutionalization refers to the creation of novel institutional practices that occur during an interregnum "between the unraveling of an established order and the dawn of a new one" (Powell et al., 2014, p. 1). An interregnum allows systems of meaning (i.e. discourse, symbols, and myths) from disparate institutional fields or focal communities to

influence emerging systems of meaning and encourages actors to collaborate and create

novel institutional practices through experimentation. The theoretical crux of the process

of proto-institutionalization rests upon collaborative relationships among multiple and

vastly different organizational actors. As organizational actors construct conversational

bridges and form collaborative relationships with others an interstitial community forms.

The interstitial community further facilitates communication among diverse

organizational communities through three mechanisms: 1) proselytization of novel

institutional practices, 2) convening to discuss emerging institutional practices, and 3)

rallying organizational support to strengthen emerging practices (Korff et al., 2015;

Powell et al., 2014). Proto-institutionalization resembles radical institutional change,

whereby a novel institutional order succeeds a former institutional order. In this manner,

proto-institutionalization may be viewed as a complex process.

     As proto-institutionalization theory seeks to explain the emergence of novel

institutional practices, complexity science offers insight into this process through the

concept of emergence. Emergence is a technical term and is the central phenomenon of

interest in complexity science (Miller & Page, 2007). Specifically, complexity scientists

posit that macro level phenomenon emerge from the micro level interaction of numerous

semi-autonomous agents (Holland 1998; Kauffman 1995; Miller & Page 2007).

Furthermore, emergence is more than the sum of constituent parts due to non-linear

processes during interaction (Kauffman, 1995, 1993). Thus, interactional processes often

amplify over time, transforming into unique, irreducible structures (Anderson, 1972).

Plowman and her colleagues (2007b), for instance, highlight how a small informal

breakfast for the homeless at Mission Church exponentially grew to a large ministry

serving over 20,000 meals annually. Owing to the ubiquity of unbounded growth, complex phenomenon frequently resembles power-law distributions (Newman, 2005). Complexity scholars demonstrate that the distribution of earthquake sizes (Newman, 2005), criminal charges per convict (Clauset et al., 2009), and connectivity within Hollywood actor networks (Barabási & Albert, 1999) all share underlying power-law distributions. Power-law distributions, consequently, are highly suggestive of complex processes (Barabási & Albert, 1999).

The mechanism underlying emergence is interaction (e.g. communication and collaboration) among numerous, semi-autonomous agents (Miller & Page, 2007). Interaction can be influenced by a variety of social forces: the cognitive limits of bounded rationality (Rubinstein 1998), culturally prescribed "strategies of action" (Swidler, 1986), or institutional "rules of the game" (North 1990; see also Meyer & Rowan, 1977). Interaction is most likely to cause emergence if control is de-centralized, meaning there is no single actor or group of actors that dictate the rules of interaction (Miller and Page, 2007). Beck and Plowman (2014) illustrate the importance of de-centralization during the aftermath of the Columbia Space Shuttle disaster, contending that no single agency coordinated every process of recovery and investigation; however, successful collaboration emerged from inter-dependent interaction among many dissimilar organizations (Beck & Plowman, 2014).

To facilitate emergence, interaction must also be goal-oriented (Kauffman, 1995). A goal orientation does not imply that all actors share a single overarching goal; rather, each actor may act in accordance to a goal that is unique to each respective agent. Groups of actors typically share common goals. Indeed, Fligstein, and McAdam (2012) contend

that actors typically compete against each other for scarce resources and structurally advantageous field positions. Adaptation results from goal-oriented actions as groups of actors encounter either positive feedback that promotes further change and the emergence of power-law distributed outcomes or negative feedback that dampens change (Miller & Page, 2007). Emergence, accordingly, requires the interaction of inter-dependent and inter-connected agents within flexible social structures (Holland, 1995; Kauffman, 1995; Miller & Page, 2007); an observation that is consistent with the theoretical framework of proto-institutionalization (Lawrence et al., 2002; Powell et al., 2014).

Prior research touts the importance of collaboration as the primary mechanism that engenders the emergence of proto-institutions (Lawrence et al., 2002; Powell et al., 2014), corresponding to complexity science's emphasis on interaction. Collaboration refers to "a cooperative, inter-organizational relationship that is negotiated in an ongoing communicative process" (Lawrence et al., 2002, p. 282). As such, collaboration implies no formal control mechanisms, enabling interaction that often catalyzes emergence (Miller & Page, 2007). Additionally, collaboration between dissimilar actors often engenders radical innovation (Carlile, 2004; Dougherty & Dunne, 2012). Therefore, previous scholarship suggests that collaboration can potentially amplify the innovative processes present during proto-institutionalization. Nevertheless, collaboration occurs in the context of organization's competing for scarce resources. It is unlikely that collaboration is the sole form of interaction within the context of proto-institutionalization. Moreover, the development of information technology alters how interaction and engagement with field-level issues occur.

Individual and organizational actors often seek to resolve shared issues, engaging in proto-institutionalization, through virtual interaction (Ince et al., 2017; Milan, 2015). Social media and webpages provide the means for actors to meaningfully engage others (Leonardi & Vaast, 2017). For example, following George Zimmerman's acquittal of Trayvon Martin's death on July, 13, 2013, the hashtag #BlackLivesMatter spread across social networking sites, Facebook and Twitter. Actors were able to use hashtags to reframe the identity of the movement by combining emerging systems of meaning together in a manner that resonated among audiences, bringing the issue of racial inequality to the forefront in American public discourse (Ince, 2017). Occupy Wall Street and Arab Spring revolutions also have their origins in social media. In this light, social media allows individuals to enter into a field and interact with an issue, whether through opposition, support, or indifference.

At its core, social media is any computer-mediated technology that facilitates users to generate content. Through social media, anyone can "create, circulate, share, and exchange information in a variety of formats and with multiple communities" (Leonardi & Vaast, 2017: 150). It includes, blogs, forums, social networking sites, newsletters, video sharing platforms, virtual worlds, social gaming, and online business reviews (Aichner & Jacob, 2015). As of 2017, the largest social networking sites count over two billion users (Facebook, 2018), pointing to their ubiquity in social life. Indeed, some organizations rely solely on social media as a medium of communication (Turco, 2016).

Actors also turn to webpages to learn about an issue or to obtain resources that they may use in their efforts to address a particular issue. For example, a webpage may contain information on income inequality, such as national statistics and personal

accounts of those living under the poverty line. The website may also offer local or national public policy to address poverty. In some cases, message boards or forums may exist on a webpage within the website, allowing individuals to further discuss poverty. The creator of the website may also include hyperlinks to other websites that share a concern with poverty, creating a network of actors. Websites, therefore, may serve multiple purposes and make different types of interaction possible.

These various forms of information technology reduce barriers to interaction and increase the likelihood of emergence. As a single post on social media can alter the beliefs and actions of a vast number of actors, information technology use often results in radical institutional change and the emergence of novel social practices. Although the assumption of equilibrium among social scientists can be contentious, much extant theory and quantitative methods implicitly assume the existence of a single point or multiple points of equilibrium (Whitmeyer, 2009). According to complexity science, system level change often follows an event that moves a system out of equilibrium, often referred to as edge of chaos (Kauffman, 1993; Miller & Page, 2007). It is in this state, particularly when resources are continuously put into a system that extreme change occurs, such as when institutions radically change or new institutions emerge (Meyer et al., 2005). Information technology may move an organizational system beyond equilibrium into the region of complexity (Beck et al., 2018).

I adopt an IT affordance perspective to understand how virtual interaction influences organizational action. IT affordances arise from the process of structuration, whereby actors enact social structures encoded within technology, altering subsequent interactional patterns (Giddens, 1984; Barley & Tolbert, 1997). Extending structuration

theory (see DeSanctis & Poole, 1994), Gal and colleagues (2014) define an IT affordance

as the "potential for action that emerges out of the interrelationships among the technical

features of the system, people's ability and predisposition to use these features in certain

ways, and the organizational context within which this takes place" (Gal et al., 2014:

1372). An affordance perspective facilitates a holistic understanding of technology use.

For example, social media affords users with the ability to enact social structures that

facilitate frequent communication. Accordingly, the potential for social action is only

realized when an actor interacts with the technology (Orlikowski, 2000).

Proto-institutionalization and fields

Proto-institutionalization occurs in a social context that consists of numerous

actors, multiple systems of meaning, and various organizational goals (Powell et al.,

2016). In this manner, the outcomes of collaboration and other organizational strategies

often depends on an organization's position within its field (Fligstein & McAdam, 2012).

Moreover, field position influences how emergence can occur. For example, an

organization that resides in the fringe of the field likely lacks the necessary

interdependent connections to enable emergent outcomes. Nevertheless, the use of

information technology and the reliance on digital interaction among contemporary

organizations necessitates a reconsideration of fields and the dynamics within fields.

Fields have a long history in organizational science. Contemporary conceptions of

fields originate from Kurt Lewin's writings (Burnes & Cooke, 2013). Lewin's field

theory posits that behavior "arises from the psychological forces in a person's life space

(Burnes & Cooke, 2013: 412). For Lewin, the life space represents a field of

environmental stimuli, prompting the equation: $B = f(p, e)$, where behavior is a function

of individual differences and the environment (Lewin, 1947). Lewin's field theory sought to map the variety of forces within the life space that impact behavior in a holistic manner. Nevertheless, Lewin's field theory lacks specificity and suggests the importance of social variables that fall outside of the psychological conception of life spaces (Martin, 2003). Contemporary approaches to field theory resemble Lewin's theory, while also emphasizing the dynamics of cooperation and contestation.

Martin (2003), extending Lewin's (1947) field theory, defines a field as a set of objects that share relational properties with one another. In this light, field theory explains causal relationships through the social relationships between two or more actors. Action within fields results from the forces of other actors (Martin, 2003). In this manner, action is interconnected. To understand action at time t, one must examine the sequence of events that occurred at time $t - 1$. Fields give rise to various forms of action. While fields may be thought of as battlegrounds, where actors compete with each other for scarce resources (Fligstein & McAdam, 2012), institutional scholars emphasize how field structures engender convergent action and field stability (Wooten & Hoffman, 2008). Marin's (2003) theorizing suggests that scholarship examine both processes within fields.

Fields coalesce around the efforts of actors that seek to address a common issue (Fligstein & McAdam, 2012; Powell et al., 2014). For example, Powell and colleagues (2016) illustrate that as members of non-profit organizations strive to develop organizational performance metrics, a field forms that encompasses non-profit organizations, governmental organizations, professional associations, and foundations that meaningfully engage with each other to innovate performance metrics. The issue prompts field formation (Hoffman, 1999). From this perspective, fields are social

contexts where actors "partake in a common meaning system and whose participants interact more frequently and fatefully with one another than with actors outside the field" (Scott, 1995, 56). The recognition of a common system of meaning does not preclude the possibility that interaction among field members is not contentious; indeed, actors often wield their power to gain positional advantages in the field (Fligstein and McAdam, 2012). Nevertheless, fields orient and coordinate the actions of disparate organizational members (e.g. Powell et al., 2016) and are the elemental structures of social systems (Fligstein and McAdam, 2012). In this manner, fields often represent the interests and shared understandings of its constituent members (Wooten & Hoffman, 2008).

Extant management scholarship typically depicts a single field structure – the organizational field – as the primary mechanism that shapes organizational action (Wooten and Hoffman, 2008). Organizational fields form around a shared concern that prompts activity, either due to a specific product (e.g. oil, semi-conductors) or an issue (e.g. environmentalism, civil rights). The organizational field encompasses organizations, such as suppliers, producers, professional associations, and the state. As such, the organizational field exerts substantial influence over the action of all members within it, as "action becomes a reflection of the perspectives defined by the group of members that comprise the institutional environment" (Wooten and Hoffman, 2008). Therefore, the organizational field constrains action into categories of legitimate action. In this manner, for a given environmental stimulus, organizational actors in the same organizational field will respond in strikingly similar ways (DiMaggio & Powell, 1983). This convergent organizational action references organizational isomorphism (DiMaggio & Powell,

1983). In contrast, recent scholarship has begun to focus on how actors pursue divergent action (e.g. Seo & Creed, 2002).

Institutional scholars contend that the collision of two or more institutional fields produce divergent organizational action by highlighting institutional contradictions to social actors (Creed et al., 2010; Seo & Creed, 2002). For example, LGBT ministers of protestant churches often perceive contradictions between their identities as LGBT persons and their identities as protestant ministers, enabling action that aims to replace existing institutional arrangements surrounding the role and practices of clergy. Organizational scholars have, however, given scant attention to the possibility that other types of fields exist alongside the organizational field.

While institutional scholars privilege the organizational field among studies of organizational action, Fligstein and McAdam (2012) contend that fields are the basic building blocks of any given social system. Strategic action fields are meso-level in nature and are very similar to organizational fields. Specifically, strategic action fields consist of actors that (1) interact frequently with one another, (2) share a common system of meaning, (3) recognizes the positions of other actors in the field, and (4) agrees on legitimate strategies of action to pursue within the field or the "rules of the game" (North, 1990). Strategic action fields are numerous and may overlap or be nestled within each other. Fligstein and McAdam (2012), for instance, contend that a department may be a single strategic action field that resides within the larger strategic action field of the company. The recognition that fields are abundant among social actors offers rich opportunities to further explain organizational action, particularly among individuals and organizational actors that interact in a digital context.

Since the forces of contestation and collaboration often occur through digitally-mediated interaction, institutional scholars must be aware of hyperlink networks (Powell et al., 2016). Hyperlink networks are the websites and links between them of organizational actors that take interest with a particular issue. Websites may convey information, seek to recruit adherents to a certain stance in regards to the organizing issue, or diffuse an emerging proto-institution among other organizations. Hyperlinks provide a point of connection among websites, allowing users to move between organizational actors. Hyperlinks also record the relational nature of the field surrounding an issue. For instance, hyperlinks are purposefully placed on a website by an organizational actor. Therefore, the structure of hyperlinks and the websites they connect to structure future action within a field and also reflect prior action.

Drawing on Fligstein and McAdam's (2012) statement that all organizational action occurs within fields and in light of the preceding discussion, I contend that the network of websites and hyperlinks surrounding a societal or organizational issue constitutes a *digital field*. The digital field uniquely structures interaction among field participants through its material properties (i.e. user generated content) and the social meaning that the websites convey. The digital field is not only an outcome, but also instrumental in the ongoing structuration of virtual interaction (DeSanctis & Poole, 1994). Accordingly, the digital field offers unique opportunities for non-linear, radical change, as interaction may occur rapidly. Virtual interaction gives rise to the potential of radical change, as seen in the dramatic growth of the Arab Spring revolutions or the Black Lives Matter movement.

Rather than supplant the organizational field, I argue that the digital field overlaps, to some degree, with the organizational field. Organizational fields consist of actors that share a common meaning system and interact frequently (Scott, 1995). In contrast the digital field may contain information without mention of a specific actor. The actor that generated content regarding an issue may have left the institutional arena, while the content remains, unmoored from its creator. In this manner, digital fields organize around issues, rather than exchange activities (Zietsma et al., 2017). Multiple digital fields may overlap at certain points, facilitating interaction in complex ways. To be sure, the organizational field and the digital field may intersect significantly in certain contexts, however, there may also be significant disjunctures. Nevertheless, the digital field structures action and facilitates the emergence of proto-institutions by providing information and a means for action.

Since the digital field consists of intense interaction among actors, complexity science can offer important insights into how the digital field fosters proto-institutionalization. First, the inter-organizational network structure or complex relational networks during proto-institutionalization likely affect the development of proto-institutions. Second, the actions of organizational leaders can affect potential collaborative relationships and enable the emergence of proto-institutions. By addressing these observations, scholars and practitioners will better understand proto-institutionalization and be able to design interventions to facilitate its emergence. Meyer and Rowan's (1977) framework unites these observations and situates them into a complex external environment. I now turn to complex networks theory and institutional leadership theory to articulate my research questions.

Complex social networks

Complexity within social networks results from the inter-dependencies and inter-connectivity between actors and directly affects emergent outcomes (Miller and Page, 2007). Positions within the field are important for actors, as those positions may allow occupants to accrue resources (Fligstein & McAdam, 2012). Although previous studies establish the essential role of network structure during proto-institutionalization (Korff et al., 2015; Lawrence et al., 2002; Powell et al., 2014) and documents the existence of dense, inter-connected networks during institutional change (Powell et al., 2005), the degree of complexity within the digital field during proto-institutionalization remains unknown.

Proto-institutionalization often occurs within collaborative networks comprising numerous disparate organizational actors (Powell et al., 2014). Lawrence and his colleagues (2002) describe the various inter-dependencies among organizations as integral for creating novel institutional practices. In addition, previous studies demonstrate that internal and external connectivity, while high in the entire organizational network, are higher in the interstitial community than in the comprising focal communities (Powell et al., 2014), implying the presence of complex social processes (Bonchev & Buck, 2005). Indeed, interactional patterns, such as those described by Powell and colleagues (2014), among inter-dependent and inter-connected social actors frequently engender complex aggregate structures (Miller & Page, 2007), observable in network topology (Barabási & Albert, 1999; Bonchev & Buck, 2005). As the digital field reflects the relational structure of activity surrounding an issue, the digital field is also likely to resemble a complex network.

Network complexity begets complex interaction patterns. For instance, a densely connected digital field indicates that information is widely available to field participants. As information becomes even more democratized, organizational activity and experimentation should increase (Dougherty & Dunne, 2011).

While recognizing that networks are complex is theoretically important, this observation does not explain the underlying processes resulting in their formation. Many types of complex networks exist; however, the model of preferential attachment has found widespread application in the social sciences (Hebert-Dufresne et al., 2011; Skorvetz, 2003). Preferential attachment posits that new nodes in a network are more likely to connect to nodes that are already highly connected (Barabási & Albert, 1999). Therefore, preferential attachment is a simple linking model that results in complex social networks.

Other social characteristics could also engender preferential attachment. For instance, Powell and his colleagues (2005) examine the contributing factors of network formation in the bio-technology industry and conclude that multi-connectivity – the cohesion and diversity of an organization's exchange partners – contributes to overall network formation. In contrast, Podolny (2005) emphasizes status, measured by deference relationships to the focal organization by partners and competitors, as a mechanism that attracts potential exchange partners. Other sources of network bias include certain institutional categories, such as: gender, race/ethnicity, age, educational attainment, and occupation (McPherson et al., 2001). Finally, according to the Matthew effect (Merton, 1968) performance can also constitute a mechanism of attraction. For instance, organizations that perform well during market competition or win awards for

the quality of their products frequently attract potential exchange partners. Therefore, a multitude of social or organizational characteristics could contribute to preferential attachment.

While preferential attachment may explain the formation of complex networks, there are other causes for the formation of an inter-organizational relationship during proto-institutionalization, such as inter-organizational collaborations. Interorganizational collaboration (IOC) refers to the coordination of work activity between two or more organizational actors towards a shared goal (Doz, 1996; Beck & Plowman, 2014; Majchrzak et al., 2015). IOCs form to address a collective problem when no single organization possesses the requisite knowledge or resources to address the problem alone (Hardy et al., 2003). Therefore, each participating organization may jointly contribute various types of resources, including monetary resources, knowledge resources, physical resources or human resources to facilitate organizational learning and collective problem solving. In this manner, IOCs organize around the task at hand (Beck & Plowman, 2014). The literature on IOC's greatly reflects many of the central mechanisms of the nascent proto-institutionalization theory. From this perspective, ties among actors and their websites form due to each party's ability to complement the others resource stock. This perspective also suggests that actors may enter into collaborative arrangements to unilaterally benefit from another's resources or knowledge.

Yet another perspective on tie formation comes from the information sciences. Information science scholars contend that there exists no universal theory of hyperlinking (Ackland, 2013), rather hyperlinks serve many purposes. This view suggests an examination of affordances. Affordances suggest that technology allows users certain

strategies of action (Leonardi & Vaast, 2017). Through the combination of information technology's material features, the dispositions of the users, and the organizational context, unexpected action may take place. For instance, the decision to create a hyperlink to another website often depends on the organizing issue (Thelwell, 2006). Shumate and Dewitt (2008) describe the hyperlinking activities among non-governmental associations seeking to address the HIV/AIDS epidemic as the creation of accessible public information. Hyperlinking may, however, also express collective organizational identities (Ackland & O'Neil, 2011), signal trust among collaborators or confer organizational status (Kleinberg, 1999). From this perspective, the digital field makes possible a variety of actions that may form inter-organizational ties during field structuration. The task of the researcher is to uncover structuration processes.

Leadership and institutions

Organizational leaders use information technology to coordinate the activities of diverse organizational communities in pursuit of a common goal, that of proto-institutionalization. In this role, leaders serve as information brokers, becoming the intermediary of crucial information regarding a field-level issue. Moreover, as the digital field is a rapidly shifting virtual environment, where social media posts or organizational websites may radically alter the meaning of emergent beliefs and practices in a short period of time, leaders' communicative strategies instill a shared understanding among relevant stakeholders. Leaders embrace complexity and use its organizing potential to guide individuals pursuing institutional work. The actions of leaders, therefore, greatly affect proto-institutionalization. Although information technology and social media provide leaders with affordances for action, proto-institutionalization likely depends on

these distinct leadership actions. The following section integrates institutional leadership

theory and complexity leadership theory to motivate my last set of research questions.

Leadership holds an important, although neglected, position within institutional

theory. Kraatz and Moore (2002) emphasize that researchers often theorize that

institutional processes, frequently institutional change, occur as the outcome of macro-

level structural forces, relegating the actions of organizational leaders to a study's

empirical and theoretical background or even excising the role of such actors from the

study's theoretical framework entirely. Indeed, Washington and colleagues (2008), after

an exhaustive review of the literature stream, lament the dearth of research that explores

the relationship between leadership and institutions. Only a handful of recent studies

consider how organizational leaders directly influence social institutions (e.g. Castel &

Friedberg, 2010; Kraatz & Moore, 2002; Tengblad, 2004). Therefore, despite Selznick's

(1957) widely held work that introduces the institutional leader as a topic of scientific

inquiry, institutional leadership theory remains in a state of disarray and fragmentation.

In *Leadership in Administration*, Selznick (1957) describes the institutional

leader's primary goal as maintaining institutional homeostasis through actions that

facilitate the formation of an organizational character or an organizational identity that is

an embodiment of social values. Selznick's central thesis is important to proto-

institutionalization scholarship primarily for two reasons. First, Selznick distinguishes

between task-oriented leadership and institutional-oriented leadership, stating that "the

executive becomes a statesman as he makes the transition from administrative

management to institutional leadership" (Selznick, 1957, p. 4). In this light, institutional

leaders concern themselves less with organizational efficiency and instead focus on

conforming internal organizational processes (e.g. employee selection processes) to external environmental demands (e.g. societal values of social justice and anti-discrimination), increasing organizational legitimacy (DiMaggio & Powell, 1983). Therefore, institutional leaders interact with other actors at organizational and often institutional boundaries to affect organizational outcomes.

Second, Selznick emphasizes how leaders' overarching task is to infuse the organization with societally legitimate values beyond the technical requirements of the organization. The primary purpose of *Leadership in Administration* is to document the patterns of action undertaken by leaders during the process of institutionalization. Selznick's central argument emphasizes the importance of leaders' actions within their social and cultural context; this holistic perspective offers interesting linkages with other non-traditional theories of leadership such as complexity leadership (Avolio et al., 2009). Selznick's seminal essay describes the location where institutional leadership occurs (i.e. at organizational and institutional boundaries) and what institutional leadership is (i.e. a pattern of observable social actions); nevertheless, due to his emphasis on stasis, Selznick's institutional leadership theory cannot fully explain the dynamic nature of institutional change.

Although Selznick's (1957) work emphasizes the static nature of institutions, recent studies of institutional leadership theory instead seek to explain how deviations from existing institutional beliefs and practices occur. Tengblad (2004), in an exploration of Selznick's (1957) theoretical framework, examines how chief executive officers (CEOs) of large organizations respond to expectations placed on them from external actors in their institutional environment, notably from the financial market sector.

Tengblad's study demonstrates that an organization's institutional environment influences leaders' beliefs and values, resulting in actions to change the process of institutionalization within their organizations. In a different study, Kraatz and Moore (2002) document three leadership actions promoting institutional change in a liberal arts college: knowledge transfer across organizational boundaries, the introduction of new mental models or cognitive schemas envisioning change through communication, and the active, intentional alteration of institutional values. Importantly, Kraatz and Moore's (2002) three leadership actions are consistent with the major findings of the organizational innovation literature that draws on complexity science (e.g. Dougherty & Dunne, 2012), particularly their emphasis on boundaries and sense-making. Similarly, Castel and Friedberg (2010) echo the previous study's findings in their analysis of how health care professionals working at French cancer centers initiated institutional change. They find that leaders who underwent divergent training in their professional careers were able to use novel institutional logics, importing them into the field of oncology and promoting evidence-based practice techniques and clinical trials.

The preceding studies underscore the importance of leaders' positions at organizational and institutional boundaries and how boundary work – actions of organizational actors that affect internal and external organizational processes – by leaders facilitates institutional change. Castel and Friedberg (2010) describe such actors as "being a part of many different environments without being central to any of them" (p. 325). Organizational leaders that span such boundaries must frequently make sense of differing systems of meaning and communicate a common discourse to other organizational actors through sensemaking and senesegiving. Weick (1995) contends that

groups continuously rearrange perceptions of their environments to reduce ambiguity. Sensemaking, therefore, refers to the ongoing accomplishment of everyday experiences (Frost & Morgan, 1983). Accordingly, organizational leaders encourage sensemaking to mitigate the uncertainty, stemming from the rapidly changing and turbulent environment that characterizes contemporary organizational reality. Following the passage of the 1963 Civil Rights Act, for example, the function of human resource management leaders was to make sense of complicated anti-discrimination policy in a manner that business leaders understood in order to avoid costly discrimination lawsuits. Sensemaking can also ameliorate problems of coordination in work teams where the individuals that comprise teams do not know each other or have diverse backgrounds (see Ahuja, 2000). Effective boundary work by organizational leaders is, therefore, intimately tied to successful sensemaking strategies.

From an institutional perspective, organizational actors may be more apt to successfully enact institutional change at institutional boundaries because it is at these social spaces that institutional contradictions become most visible (Seo & Creed, 2002; Voronov & Yorks, 2015). Institutional contradictions describe the inconsistencies and irregularities that occur between different institutional fields that are often incompatible (Friedland & Alford, 1991; Seo & Creed, 2002). Illustrating the nature of institutional contradictions, Dunn and Jones (2010) describe how logics of care – values that emphasize "physicians' clinical skills used to treat patients and improve the health of the community" and logics of science, values which emphasize "knowledge if diseases built through research and innovative treatments," exist in contestation within contemporary American medical education curricula. Institutional contradictions can engender tension

and conflict, in addition to innovation (Seo & Creed, 2002). Moreover, as actors experience institutional contradictions, depending on their institutional embeddedness and their psycho-social development, they may be more apt to perceive institutional arrangements as temporary and malleable (Voronov & Yorks, 2015) resulting in the possibility for institutional leadership that can facilitate institutional change.

Washington and colleagues (2008), drawing on Selznick's (1957) thesis on institutional leadership and the contemporary research stream, expand beyond a focus on institutional boundaries. They posit that institutional leaders strive to maintain institutional consistency, amass external resources through internal organizational processes, and use those resources to overcome external adversaries. Although Washington and colleagues (2008) provide a useful conceptual framework for understanding contemporary institutional leadership, their description fails to account for how an institutional leader facilitates the emergence of proto-institutions or novel institutional arrangements. To address this gap, I turn now to a discussion of complexity leadership and complex innovation theories to explain how institutional leaders enable proto-institutionalization.

Institutional leadership from a complexity lens

Complexity leadership theory incorporates numerous arguments from complexity science to explain how leaders enable adaptive change in an organizational context (Uhl-Bien et al., 2007). Adaptive change may refer to the emergence of an organizational innovation (e.g. Plowman et al., 2007a). From a leadership perspective, complexity science highlights various aspects of leadership that traditional leadership theories ignore, such as a holistic perspective of leader-follower interactions (Marion & Uhl-Bien, 2001).

Moreover, complexity leadership theory echoes many of the foci of institutional leadership theory, particularly Kraatz and Moore's (2002) arguments regarding sensemaking and various authors' emphasis on institutional and organizational boundaries. Theoretical integration of these two research streams will, therefore, be especially important for the development of proto-institutional theory.

Traditional leadership theories articulate how leaders set specific organizational goals and exert authority over followers, motivating and inspiring their followers to attain those goals (Avolio et al., 2009). Marion and Uhl-Bien (2001) contend that traditional leadership assumes that "leadership is interpersonal influence," whereby organizational outcomes depend on the combination of "leader attributes and follower emotions" (p. 391). Moreover, goal setting behavior assumes that the social world is relatively stable, permitting leaders to predict future states and inspire followers to achieve those states (Marion & Uhl-Bien, 2001; Uhl-Bien et al., 2007).

Complexity leadership theory largely rejects the theoretical and philosophical assumptions that underlie traditional leadership theories (Boisot, & McKelvey, 2010; Marion & Uhl-Bien, 2001). Although complex leaders rely on interpersonal influence to guide followers, Marion & Uhl-Bien (2001) contend that interpersonal influence in isolation "may not tell the full story" (p. 391); complexity leadership theory's framework embraces the social context in which interpersonal influence occurs. Complexity theorists recognize that the social and physical world consist of agents who often exhibit a high degree of inter-connectivity and inter-dependence (Boisot & McKelvey, 2010; Miller & Page, 2007). For instance, numerous monetary transactions, many of which are dependent on the outcomes of other transactions, constitute national economies

(Anderson, 1999). Removing a single economic transaction from an economy will have little effect on the overall economic system; therefore, economies must be understood holistically and not through the atomistic lens of scientific reductionism. Observations of such systems – social and physical – have led complexity theorists to reject reductionism and determinism as epistemological assumptions (Boisot & McKelvey, 2010). Systems theorists in the organizational sciences have, moreover, long made such claims regarding the need to understand social systems in an organizational context as a phenomenon that is irreducible to its component parts (Scott & Davis, 2007). These theorists contend, for instance, that innovation is beyond the capability of any single member and that innovation only emerges through the inter-dependent interactions of numerous organizational members (Dougherty & Dunne, 2012).

Apart from the philosophical underpinnings of complexity science, the central thesis of complexity leadership theory posits that, while uncertainty in the organizational environment undermines the traditional goal-authority actions of leaders, leaders must engage in action that enables or guides the emergence of desirable organizational outcomes through the interaction of individuals, ideas, and physical resources (Uhl-Bien et al., 2007; Plowman et al., 2007b). Complex leaders seek, therefore, to eliminate different types of barriers (e.g. cultural, physical, and financial) that may prevent interaction among organizational members (Marion & Uhl-Bien, 2001). Furthermore, the agents in the system that interact (e.g. individuals, organizations, ideas etc.) may be different from each other due to diverse biographical experiences or their relationships with various institutional fields. Such differences can pose significant coordination challenges (Ahuja, 2000) but also can promote innovative outcomes (Dougherty &

Dunne, 2011, 2012; Yang & Konrad, 2011). In this light, complex leaders bridge both

relational boundaries by introducing two individuals who were unknown to each other

and informational boundaries by translating context specific discourse between diverse

communities to enable innovation (Carlile, 2004; Dougherty & Dunne, 2012; Obstfeld,

2005).

Additionally, traditional leadership theories largely ignore the dynamic context

that proto-institutionalization occurs within – the digital field. As an institutional arena

ripe with collaboration and contestation among numerous actors, systems of meaning are

constantly shifting. Moreover, the use of information technology may engender complex

organizing processes, particularly in collaborative contexts (Beck et al., 2018). In this

light, complexity leadership offers a contextualized perspective of leadership, one within

the affordances of a socio-technical system. For this reason, complexity leadership is

useful to explain proto-institutionalization in a digital context.

From this discussion, two types of actions are particularity important for leaders

to engage in to promote social innovation: building diverse social networks and making

sense of the rapidly shifting context upon which innovation depends. I now turn to each

of these actions and offer corresponding research questions.

Leading proto-institutionalization through network strategies

Institutional leaders often make sense of discourse from diverse institutional fields

to bridge social and cultural boundaries and to facilitate coordination among various

organizational actors (Washington et al., 2008). In order to enable institutional change,

leaders must often cross the boundaries of disparate institutional fields (Kraatz & Moore,

2002), requiring that leaders impart meaning to the collective experiences of

organizational members. David and colleagues (2013) illustrate that during the institutionalization of professional management consulting organizations institutional entrepreneurs had to rely on their social networks, especially structural holes between institutional fields, to establish legitimacy and a high status. For instance, the management consultant, James McKinsey, held a faculty position with the University of Chicago's business school where he published numerous books and helped develop the undergraduate curriculum; such ties to academia gave McKinsey's consulting company high status among business leaders. From this perspective, Castel and Friedberg (2010) contend that innovation often results from exposure to more than one institutional order, underscoring the important position of actors that cross boundaries. Indeed, the boundaries of institutional fields often magnify incompatibilities and contradictions, freeing actors to experiment with novel ideas, without the iron cage of institutional pressures to constrain action (Seo & Creed, 2002).

The findings from institutional studies reinforce studies from a complexity science perspective describing how complex leaders bridge structural holes to catalyze emergent innovation (Plowman et al., 2007b; Beck & Plowman, 2014). Plowman and colleagues (2007b) emphasize how early during the organizational change process the organizational leaders strategically united organizational members hoping to form a collaborative relationship. Management scholars emphasize network structure as an enabling condition of innovative outcomes (Ahuja, 2000; Carlile, 2004; Ferrary & Granovetter, 2009; Obstfeldt, 2005). In this light, effective organizational leaders must successfully bridge the relational and informational boundaries between organizational actors (Carlile, 2004).

Obstfeld (2005) refers to such network enhancing actions as a behavioral orientation towards social networks or as *tertius iungens*. An individual possessing a high degree of social network orientation is more likely to introduce individuals strategically to each other that may be beneficial for organizational goals. For example, the development of novel pharmaceutical drugs requires the close collaboration of vastly different groups "digital scientists" and "therapy scientists," however, only some scientists actively participate in bridging these institutional communities (Dougherty & Dunne, 2012). Organizational leaders enable the emergence of innovation through both diverse and dense social networks (Ahuja, 2000; Dougherty & Dunne, 2012; Miller & Page, 2007; Obstfeld, 2005).

Leaders within the digital field are, therefore, likely to negotiate social interactions across relational and informational boundaries. Such leaders make use of information technology and digital media to serve as informational brokers, connecting together disparate communities. Moreover, a leaders' network orientation should facilitate the emergence of complex social networks at the macro-level as the result of continuous network building actions at a micro-level.

Leading proto-institutionalization through discursive strategies

Although several sets of leadership actions are integral to the emergence of innovation, discursive strategies, such as "tags," narratives, and sensemaking are particularly important during institutional change (Washington et al., 2008), during enactments of complexity leadership (Bartel and Garud, 2009), and likely integral during proto-institutionalization. Complex leaders often act as "tags" (Marion and Uhl-Bien, 2001), uniting disparate organizational actors and meaning systems, which catalyzes

innovative processes. Due to the high degree of environmental uncertainty and ambiguity within organizational contexts, tags facilitate leaders' efforts to make sense of emerging systems of meaning and reduce uncertainty. Absent such sensemaking, actions of coordination and control among organizational actors will likely preclude the emergence of successful emergent organizational outcomes (Weick, 1995). For example, during radical organizational change at Mission Church, the pastors became tags by synthesizing radical emergent change with Biblical scripture, providing a shared mental model that organizational members were able to use to understand how the organization was changing (Plowman et al., 2007b). In this manner, "tags" promote internal consistency within the organization, reminiscent of institutional leadership (Kraatz & Moore, 2002; Washington et al., 2008). Additionally, through enacting common meaning systems, complex leaders enable and maintain organizational identity (Schneider & Somers, 2006), or an organization's character (Selznick, 1957).

While tags facilitate the establishment of systems of meaning common across organizational members, various communicative and social vehicles may contain tags. Boal and Schultz (2007) propose that organizational narratives contain tags that enable organizational leaders to "articulate their visions by telling stories and promoting dialogue in which an organization's past, present, and future coalesce" (Boal & Schultz, 2007, p. 426). Plowman and colleagues (2007) refer to the use of language and discursive strategies as a mechanism for promoting sensemaking as correlation. They contend that correlation identifies the constellation of people, objects, and actions within a specific organizational context, permitting organizational leaders to unite those agents with taken-for-granted scripts and logics understandable to organizational members and

stakeholders (Plowman et al., 2007b). Organizational leaders cannot impose narratives or correlation on others. Rather, organizational members each construct their own organizational narratives through their unique experiences, modifying those narratives through interaction with others, including organizational leaders, resulting in shared mental models regarding radical change (Boal & Schultz, 2007; Gioia & Sims, 1986).

While complexity leadership scholars emphasize how narratives promote shared understandings, complex innovation scholars provide a complementary perspective by underscoring how narratives function at organizational boundaries. Accordingly, innovation scholars frequently cite the capability of narratives to catalyze the generation of novel ideas (Dougherty & Dunne, 2011; Bartel & Garud, 2009). Bartel and Garud (2009) illustrate how innovation narratives resolve coordination problems that can often occur at organizational boundaries (Carlile, 2004), serving as boundary objects that individuals may use to facilitate understanding. Narratives can facilitate coordination among disparate actors through the preservation of important surface level details of specific ideas or events within narrative plots. Plots arrange characters into a sequence of events and situations (Rhodes & Brown, 2005) and convey frames of how to see the world that are meant to resonate with an audience (Boal & Schultz, 2007). Such plots frequently depict organizational 'heroes' taking a certain action to contribute to the demise of an organizational 'villain' (Battilana et al., 2009). Importantly, individuals, regardless of their previous experiences and knowledge, are likely to understand the significance and remember details within narrative structures (Bartel & Garud, 2009).

Narratives, as a discursive strategy, are also crucial during institutional change and institutional innovation, as advocated by the recent communication turn in the extant

literature (see Cornelissen et al. 2014). Powell and his colleagues (2015) posit that organizations must construct conversational bridges to proselytize and strengthen emergent institutional practices. Discursive and rhetorical strategies, bridging conversational chasms, require the use of multiple forms of media and fluency in various institutional languages. From this perspective, the digital field offers many possibilities of discursive strategies through social media or video hosting services. Zilber (2002) contends that institutionalization requires actions to be infused with value-laden meanings through the translation of rational institutional myths into context specific myths; moreover, the successful translation of the information within narratives depends on dynamics within the broader institutional environment at the time of translation.

The actions of organizational leadership to guide sensemaking efforts constitute a crucial task for organizational outcomes, such as change and innovation. While collaboration across institutional and organizational boundaries fosters innovation, such diversity also hinders the coordination of work necessary to transform an idea into a product or a social practice (Bartel & Garud, 2009). Organizational narratives reduce uncertainty, structuring the environment into a readily understandable sequence of events that allows organizational members to collaborate through effective division of labor. The role of the leader is, therefore, to promote the emergence of such narratives or tags and to guide their continuous reproduction. Many questions remain regarding how leaders use narratives in a virtual context. Specifically, I ask how do leaders strategically use narratives or modify existing narratives to align with organizational goals. Extant scholarship documents how organizational members respond and use narratives; however, how leaders interact with narratives remains unclear.

While the discursive strategies of leaders are a crucial mechanism that facilitates proto-institutionalization, the skillful use of discourse is even more important in a digital context (Powell et al., 2016). Digital communication that resonates with others may be seen by millions of individuals and engender widespread change. Such communication is different than face-to-face strategies which rely on the charisma of the leader. From this perspective narratives take on more importance when the mode of communication is virtual. In an online context, leaders may use creative combinations of words, images, and videos to convey a narrative plot. Additionally, leaders may use other communicative strategies, such as blogs or social media to instill an internal consistency within their organization amongst an ambiguous environment. The use of discursive strategies remains an open empirical question.

The preceding discussion identifies major theoretical gaps within the proto-institutionalization and institutional change literatures. I especially emphasize that how organizational leaders construct conversational bridges and facilitate the creation of network ties to enable the successful emergence of proto-institutions; therefore, putting the concepts of social networks, narratives, and sensemaking, in the context of leadership, under an analytical microscope. Moreover, digitally mediated interaction places considerable theoretical and practical importance on such leadership strategies. For instance, social scientists do not know how organizational actors instill their organization with social value in a digital context or how organizational leaders use discursive strategies, motivating the following research question:

Information technology and social media clearly influence the process of proto-institutionalization. While other studies recognize the importance of the fields that

coalesce around issues and the efforts of actors within those fields (e.g. Hoffman, 1999),

scant attention has been given to fields that exist, in part, as socio-technical artifacts.

Such fields consist of organizational and personal websites, social media activity, and the

hyperlinks that connect them. I introduce this construct as a digital field and contend that

the digital field uniquely structures action and thus impacts processes germane to proto-

institutionalization in unique and often non-linear ways. Research questions 1 and 2

provide insight into the structure of the digital field and are necessary to establish the

digital field as a fundamental aspect of contemporary institutional processes. Specifically,

research question 1 seeks to address the complexity (Miller and Page, 2007) of the digital

field, offering a glimpse of the digital field's proclivity to facilitate radical institutional

change. Research question 2 asks about how collaborations form in the digital field,

illuminating the action that underlies the structure of the digital field.

In the context of the digital field, the actions of organizational leaders are crucial

for successful proto-institutionalization. Through their ability to unite actors that possess

critical knowledge about an issue and their ability to impart meaning in an ambiguous

environment, organizational leaders influence proto-institutionalization. Organizational

leaders may introduce actors that belong to disparate organizational communities in an

effort to assemble the necessary knowledge to address a shared problem. Accordingly,

research question 3 asks how information technology and social media in particular may

further bolster a leader's ability to strategically craft a network of innovation. On the

other hand, organizational leaders also may engage in sensemaking and sensgiving

actions to create meaning in uncertain environments. Research question 4 investigates

this phenomenon by highlighting the use of discursive strategies and specifically

narratives among leaders. Addressing all four research questions illuminates the macro-micro connections within the digital field.

The preceding discussion motivates the following research questions relating network structure and the process of collaborating among members of the digital field, including leadership actions that further proto-institutionalization:

RQ₁: What is the network structure of the digital field?

RQ₂. How do inter-organizational relationships form in the digital field?

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RQ₃: How do organizational leaders enable the emergence of proto-institutions through network enhancing actions in the digital field?

RQ₄: How do organizational leaders enable the emergence of proto-institutions through discursive strategies in the digital field?

CHAPTER 3. METHODOLOGY AND PROCEDURE

Research Design

The present study employs a mixed-methods research design, comprised of quantitative network analysis and qualitative grounded theory methodology. Mixed methods designs mix or integrate quantitative and qualitative data to answer research questions that each method cannot address in isolation (Creswell, 2003). For this study, a mixed methods design is appropriate because complex social processes often result in the emergence of a phenomenon "across multiple levels" of analysis (Dooley & Lichtenstein, 2008, p. 270). For example, this study examines social processes at the macro-level (i.e. digital field) and at the micro-level (i.e. actions of organizational leaders) and across various temporal contexts (i.e. past, present, and future). Complexity scientists contend that traditional quantitative designs such as those employing multiple regression analyses fail to fully capture the variety and the dynamic nature of complex phenomena (Boisot & McKelvey, 2010; Byrne, 1998). For instance, emergence occurs due to the interaction among numerous, dissimilar agents (Miller & Page, 2007). Under such conditions, an observer may identify more variables than the quantity of agents that may influence interaction, making regression analysis a suboptimal method of analyzing complex phenomenon (Boisot & McKelvey, 2010). Addressing this limitation, complexity scientists advocate the use of other types of quantitative methods, such as computational simulations (Hazy, 2007) or social network analysis (Dooley & Lichtenstein, 2008) to study complex social phenomenon. Qualitative research methods also provide additional insights into complexity by allowing individuals to construct a rich description of their

experiences and understandings of events that contains information on numerous variables across time and at multiple levels of analysis (Plowman et al., 2007b).

I use a sequential explanatory mixed methods design, where qualitative data contextualizes, explains, and makes sense of quantitative data (Creswell, 2003). Quantitative network analysis answers the first research question, describing the complexity of the digital field. I then, through qualitative data collection and analysis, attempt to understand and explain the overall relational structure of the digital field identified during the network analysis. The qualitative data, therefore, answer research questions two, three and four.

Greene and colleagues (1989) provide a useful discussion of the various contributions that a mixed methods design possesses. Such contributions strengthen the research and permit the analyst to better answer their research questions. Although their discussion emphasizes five general strengths of mixed methods research, two justifications for mixed methods research are particularly applicable to this study. First, the union of quantitative and qualitative research can be complementary by providing "elaboration, enhancement, illustration, clarification of the results from one method with the results from another" (Greene et al., 1989, p. 259). Network analysis, therefore, provides descriptive information regarding the phenomenon of interest, complex relational networks within the digital field, while qualitative interviews provide information regarding the processes underlying the formation of complex relational networks, as the result of leaders' actions. Second, one method can contribute to the development of another method at a later stage of the research. Consistent with this point, I use network analysis to highlight various aspects of relational ties between actors in the

organizational community that advocates diversity practices in computer science education; findings from the network analysis have aided to refine the interview protocol and facilitate the iterative movement between data collection and data analysis characteristic of grounded theory studies (Charmaz, 2000, 2006). Despite the strengths of mixed methods designs, scholars suggest that analysts must make certain assumptions to mix quantitative and qualitative methods.

Bryman (2011) cautions that the use of mixed methods can result in epistemological and ontological inconsistencies during the interpretation of quantitative and qualitative data by the researcher. For example, quantitative researchers often adopt a positivist paradigm, emphasizing the measurable characteristics of the social world that exist apart from the researcher. On the other hand, qualitative researchers contend that both the researcher and the participant co-construct data, emphasizing the subjectivity within social research where social action exists as a negotiated accomplishment of reality (Charmaz, 2006). Each of these accounts of the ontology of social life suggests certain methodologies, such as surveys or interviews, respectively. In contrast, Yanow and Ybema (2011) contend that while mixed methods designs combine two or more methods, this combination does not force integration of epistemological and ontological assumptions; rather each method addresses different aspects or characteristics of a social phenomenon. As I delay the integration of the methods until the interpretation stage of the research, I agree with Yanow and Ybema's central argument and also adopt methodological practices from complexity science to further address the philosophical inconsistencies between the quantitative and qualitative methods.

Complexity scientists, invoking Ashby's (1956) law of requisite variety, address and attempt to bridge the ontological inconsistencies between quantitative and qualitative paradigms (Boisot & McKelvey, 2010). In this light, research on complexity in the organizational sciences should balance the observation of a variety of stimuli (i.e. rich, thick description typical of qualitative methods) with the observation of a variety of responses (i.e. large sample sizes suitable for generalization typical of quantitative methods) in a manner that is "complementary and contingent" to the researchers' particular interests and the characteristics of the phenomenon of observation (Boisot & McKelvey, 2010, p. 424). From this perspective, a case that exhibits properties of complexity permits a mixed methods research design. Moreover, by collecting data at multiple levels of analysis, as complexity scientists suggest, the researcher may create theories that span levels of analysis and research methods without violating philosophical assumptions of any one particular theory or method, as each method addresses a different level of analysis. This research adheres to the recommendations of Boisot and McKelvey (2010) by collecting quantitative network data at the macroscopic level of the digital field and by collecting qualitative interview data at the level of the microscopic organizational leader. In this manner, the analysis of each type of data does not violate underpinning assumptions Additionally, as I delay theoretical integration of the findings of each methodology until after data collection and analysis, I further avoid incorporating ontological and epistemological inconsistences in my theoretical model.

Finally, Ivankova and colleagues (2006) discuss several procedural issues that researchers using sequential explanatory research designs must take into consideration. Two procedural issues are especially relevant to this study. First, the researcher must

make a determination of priority regarding weight or importance of the quantitative and qualitative methods. I give priority in this study to the qualitative methods, since the qualitative methods correspond to three research questions and the answers to those questions contributes the most to the overall purpose of the research (Morgan, 1998). Second, Creswell (2003) discusses that the integration of quantitative and qualitative methods can occur at various stages of the research process. I integrate the two methods during the interpretation stage of this research project (Ivankova et al., 2006). Accordingly, no research question is addressed by more than one method, further ensuring that this study does not violate any of the philosophical assumptions that govern quantitative and qualitative research designs.

Research context and data

The issue of gender and racial/ethnic diversity within computer science education serves as the context for this study. Despite much interest from business leaders, policy makers, and educators towards diversifying gender and racial/ethnic representation among undergraduate students in computer science education, there has been no set of institutionalized 'best practices' so far to emerge from this effort. In fact, the percentage of women who earn bachelor degrees in computer science has fallen substantially since the 1980s, while the percentage of African Americans and Hispanics that attain bachelor degrees remain in the single digits (Brinkman & Diekman, 2016). Such figures are startling, considering the large empirical evidence that demonstrates diversity within project teams contributes to positive organizational outcomes, such as innovation and creativity (Dougherty & Dunne, 2012; Yang & Konrad, 2011). The enduring lack of diversity in computer science education is a multifaceted problem that spans from

primary education to employment (Brinkman & Diekman, 2016). As such, addressing this lack of diversity demands collaboration among organizational actors since no single actor is likely to possesses the necessary knowledge and skill to innovate a solution alone.

There have been several calls for collaboration in computer science education to address issues of diversity. Prior to 2006, diversity initiatives were largely individual ventures, where a single organization sought to enter into a collaborative relationship with a school or university, such as a non-profit organization hosting programming workshops at a local high school. In 2006 the National Science Foundation's (hereafter NSF) Broadening Participation in Computing program sought to bring together colleges and universities, non-profit organizations and for-profit organizations into alliances of innovation. By 2007 there were ten NSF alliances across the United States, each with a distinct set of goals, such as serving Hispanic college students or increasing African American graduate degree attainment and entry into the professoriate. Moreover, the National Science Foundation has recently made substantial investments into the next generation of collaborative ventures. In addition to initiatives by non-profit organizations, business leaders have also sought to engage in the creation of diversity initiatives. For example, Google and other industry leaders collaborate with the non-profit, Black Girls Code, to deliver workshops and after-school programs.

Digitally mediated interaction is commonplace among advocates of diversity in computer science education. Institutional pressures within the organizational field increase the likelihood of digital engagement. For example, the National Science Foundation (NSF), a major source of funding for diversity initiatives, requires that

recipients of funds detail a plan for the dissemination of their work. Dissemination

includes, but is not limited to organizational websites, blog posts, and social media

activity. Websites often contain sections for others to learn about diversity initiatives,

while also making other relevant information readily available. Virtual newsletters also

circulate among actors, containing current trends among educators and touting corporate

sponsorships and associations. Due to the collaborative nature of computer science

education advocates and the prominent role of information technology during their work

activities, the diversity crisis within computer science education is an ideal context for

my study.

Collaboration is meant to foster the development of proto-institutions or novel

diversity practices (Lawrence et al., 2002). Novel diversity practices vary substantially;

for instance, a new diversity practice could include the implementation of a *Lego

Robotics* workshop taught by undergraduate college students to elementary school

students with the motivation to encourage interest in computer programming. Such

practices are not standard among the organizational community and vary significantly

among individual organizations.

Due to the preceding considerations, the context of diversity in computer science

education serves as an appropriate case to examine how the digital field influences proto-

institutionalization. Specifically, I chose this case as a theoretical sample (Yin, 1994) to

observe the intersection of information technology and proto-institutionalization.

Theoretical samples enhance the potential to build theory by ensuring that 'extreme

cases' are readily observable (Eisenhardt, 1989). From this perspective, many cases of

proto-institutionalization would not provide insight into how leaders use information

technology to innovate institutional practices (e.g. Lawrence et al., 2002). Moreover, Ragin and Becker (1992) contend that cases are themselves complex systems where understanding relationships among constructs depends on holistically examining all parts of the case. From this perspective, case-based research complements a complexity science perspective (Byrne, 2009).

I collected data for this study from two primary sources to support my mixed methods research design. For the quantitative portion, I collected network data from websites that advocate for diversity practices in computer science education. For the qualitative portion, I collected interview data, and obtained organizational documents. Each type of data is situated within the context of diversity practices in computer science education. I now turn to discuss each type of data and associated method of analysis in greater detail.

Phase 1. Quantitative methodology and data

To address the first research question, I follow prior research (Korff et al., 2015; Powell et al., 2014), and use web crawler technology to collect hyperlink network data on organizations and individuals engaging in the proto-institutionalization of diversity practices in STEM education – the digital field. Web crawlers track hyperlinks embedded within webpages to capture overall network structure (Ackland, 2013). In this manner, each organizational website constitutes a single node in the network while hyperlinks represent the links connecting the nodes together. Hyperlinks are particularly advantageous because they reflect conversations between organizations; organizations that collaborate together to solve a shared problem will often indicate the relationship on their website (Powell et al., 2014).

I use the web crawler tool, *The Virtual Observatory for the Study of Online Networks* or VOSON (http://voson.anu.edu.au/), to collect a sample of organizations engaging in the proto-institutionalization of diversity practices. VOSON has been extensively used to study social movement organizations (Ackland et al., 2006; Ackland & Gibson, 2004). Indeed, "VOSON has been specifically designed for collecting inter-organizational hyperlink networks and analyzing these networks using SNA [social network analysis] techniques" (Lusher & Ackland, 2011).

VOSON requires the input of several initial webpages – seeds – and from these initial seed websites tracks all of their hyperlinks to other webpages, much like a snowball sample. This approach allows the researcher to identify a community of organizations without imposing potentially biased inclusion criteria on the sample. Accordingly, I identified 23 seed webpages (see Table 1), in consultation with subject matter experts, to begin the web crawl process. The sampling frame, therefore, is comprised of organizations that engage in the proto-institutionalization of diversity practices in computer science education.

As the nature of the digital field is an open empirical question, I diverge from prior research that views hyperlinks as an indicator of collaboration (e.g. Powell et al., 2014). Such studies restrict their samples to include only organizational websites that share a bi-directional hyperlink with at least one other organizational website in the sample (Korff et al., 2015; Powell et al., 2014). This restriction decreases the probability that the sample of organizations will contain cases that have diversity related hyperlinks on their webpages merely for purposes of institutional legitimacy; such organizations are unlikely to exert effort and provide resources for the purpose of proto-institutionalization

(Powell et al., 2014). this restriction may, however, also undermine important aspects of the digital field. I report on the bi-directional hyperlinks in my sample, but my sample makes no restrictions based on bi-directional links.

Additionally, hyperlink data are messy (Ackland, 2013). Irrelevant hyperlinks are often captured during a web crawl. This sample contains online websites that contain information regarding computer science education diversity. Following sample collection, I ensured that each website was germane to computer science by viewing them. I removed any websites that did not fit my sampling frame. For example, I removed a website that contained information on astrology. In total, I identified 280 websites that were not members of the digital field and therefore excluded from the social network analyses. The final sample of organizations contains several thousand websites, comprising information on links with other websites.

Quantitative analysis

Following sample collection, I use social network analysis software to analyze the hyperlinks among websites promoting diversity practices. I use the *NodeXL, MatLab,* and *Gephi* software packages to analyze the network data and create the network visualizations. I include several measures of complexity and other common forms of social network measurement to explain the complexity of my sample. For the social network analysis all measures are implemented on an undirected network of my sample, except for measures of influence. I will now discuss each of those measures in greater detail.

Measures

I include several descriptive measures of network topography to my sample. First, I measure network density. Network density refers to the ratio of potential links among nodes in a particular network to the actual number of links among nodes in a particular network (Wasserman & Faust, 1994).

Next, I include several measures that capture a node's importance or influence within a network. First, I use eigenvector centrality, as a robust measure of a node's importance. Eigenvector centrality examines both a focal node's connections to it nearest neighbors, but also the focal nodes neighbors' connections to other nodes. Eigenvector centrality expands on the degree centrality measure. Degree centrality refers to the total connections that a focal node possesses and will be discussed in greater detail below. Eigenvector centrality acknowledges that every connection does not carry equal importance in the network; some connections are more valuable than others. The Eigenvector centrality measure attempts to reconcile this problem by reflecting information about a focal node's neighbors degree measures (Wasserman & Faust, 1994). The algorithm for eigenvector centrality returns a value between 0, indicating little significance, and 1, indicating high significance. To best illustrate eigenvector centrality, I graph the distribution of all the eigenvector centrality measures in my sample.

I also include two measures that examine a node's influence in a network. Both of these measures were developed particularly for hyperlink data. These measures are PageRank (Brin & Page, 1998) and HITS (Kleinberg, 1999). For both of these measures, I use the directed graph of the hyperlink network. PageRank is the primary algorithm for the search engine Google (Brin & Page, 1998). PageRank uses the in-bound and out-

bound hyperlinks of a focal website to identify the probability that a person randomly clicking on hyperlinks will arrive at the focal hyperlink. This algorithm returns a probability for arriving at a particular website. I graph the distribution of the PageRank values in the sample to better illustrate the dispersion of influence in the digital field. I also use the HITS algorithm (Kleinberg, 1999). HITS examines two related properties of networks: hubs and authority. Hubs are important because some web pages contain many links and are repositories of information yet hold little influence within the network. In contrast, authority refers to the influence of a website. Under the HITS algorithm, a good hub contains many hyperlinks to other authoritative websites, while a website with high authority receives many hyperlinks from hubs. Therefore, the HITS algorithm provides values for a measure of hubs and authority for each website in the sample. The value of these measures ranges from 0 to 1. I graph each of these measures for the entire sample. Together, eigenvector centrality, PageRank and HITS describe the structure of authority and influence within the digital field, complementing the other network measures.

I apply several measures the describe network complexity – the network complexity index – on my sample. The network complexity index comprises of three measures – degree distribution, average path length, and the average clustering coefficient (Wang et al., 2011). A network is complex if it 1) follows a power-law distribution, 2) has a short average path length, and 3) has a large average clustering coefficient. To describe a network as complex it must adhere to each of these measures. Additionally, I also investigate the community structure within the digital field to better understand partitions of the digital field and complement the average clustering coefficient.

First, I use Barabási and Albert's (1999) measure of degree distribution. A node's degree refers to the number of links that a node shares with other nodes. For example, a website that contains three hyperlinks to other websites has a degree of three. The degree distribution is a graph of the degree of each node in the total network. Moreover, the degree distribution is closely related to overall connectivity (Bonchev & Buck, 2005). To examine complexity, the degree of each website is plotted on a graph. A degree distribution that approximates a power-law distribution indicates network complexity (Wang et al., 2011). From this perspective, a complex network contains a relatively small number of nodes that possess extremely high degrees, while the majority of nodes in the network possess relatively sparse connections.

Recent studies find, however, that visually inspecting an empirical distribution is not sufficient to determine whether the data follow a power-law distribution. Clauset and colleagues (2008: 1) contend that "the detection and characterization of power laws is complicated by the large fluctuations that occur in the tail of the distribution." To address this issue, they introduce a maximum likelihood estimation algorithm using the Kolmogorov-Smirnov statistic. First, an algorithm, using maximum likelihood estimation, fits a power-law function to empirical data. The power-law function takes on the following form: $f(x) = x^{-\alpha}$. Then the estimated power-law function is plotted on a log-log graph with the empirical data. Power-law functions follow a diagonal path on a log-log graph (Coles, 2001). Finally, they calculate the Kolmogorov-Smirnov test statistic, D, which assess the amount of uncertainty between the estimated power-law function and the empirical data. Together, each of these steps are necessary to determine whether an

empirical distribution adheres to a power-law function (Clauset et al., 2008) and,

therefore, indicates complexity (Wang et al., 2011).

I also measure the network's average path length. The average path length reflects

the mean quantity of links that connect the shortest paths in the network (Watts &

Strogatz, 1998). A tightly linked network will have a shorter average path length – L –

than a sparsely connected network. d_{ij} refers to the shortest path length from nodes i to j.

A smaller measure for average path length indicates a high level of network complexity.

In other words, one needs only to traverse a few nodes to pass through the network. The

formula follows:

$$L = \frac{1}{\frac{1}{2}n(n-1)} \sum_{i>j} d_{ij}$$

Finally, Wang and colleagues (2011) include the average clustering coefficient of

the network in their index of network complexity. C_i refers to the clustering coefficient

and is the ratio of the number of edges, E_j, in a nodes neighborhood to the total possible

number of edges, $k_i(k_i - 1)/2$ (Watts & Strogatz, 1998). A large clustering coefficient

indicates network complexity (Wang et al, 2011). The formula follows:

$$C_i = \frac{E_j}{k_i(k_i - 1)/2}$$

To interpret the average path length and the average clustering coefficient I

generate a random network of the same size as my sample. A random network contains

arbitrary links among the nodes of the network and permits comparison between the

empirical measures of complexity and those of the random network (Wang et al., 2011).

In addition to measuring the average clustering coefficient, I also implement

community detection methods on my sample. While the average clustering coefficient

describes the homogeneity of ties within a network, community detection methods use algorithms to identify the composition of specific clusters of nodes. In particular, I use the Louvain method of community detection. The Louvain method is an iterative method that optimizes the community structure of a network to identify the best possible community structure within the network. Specifically, the algorithm continues until the ratio of the density of links outside any particular community to the density of links within a particular community is the smallest possible value (Blondel et al., 2008). In this manner, the Louvain method moves beyond a single summary measure of clustering and identifies each community within the network. Therefore, the Louvain method complements the average clustering coefficient by actually identifying which nodes belong to which community, providing a much better illustration of the structure of a network.

Although quantitative network analysis provides substantial insight into the structure of the digital field, it is not able to elucidate the mechanisms that underlie the digital field's structure. How actors interact with each other and with what technology and the social meaning that they ascribe to such interactions facilitate the formation of the digital field and the processes of proto-institutionalization. To further investigate the processes underlying network topology and to gain a richer understanding of those social processes, I turn to the qualitative data and methods.

Phase 2. Qualitative methodology and data

To better answer research questions two (i.e. *How do inter-organizational relationships form in the digital field?*), three (i.e. *How do organizational leaders enable the emergence of proto-institutions through network enhancing actions in the digital*

field?), and four (i.e. *How do organizational leaders enable the emergence of proto-institutions through discursive strategies in the digital field?*), I employed grounded theory methodology (Charmaz, 2000, 2006; Strauss & Corbin, 1998) and collected qualitative data to answer the research questions. I conducted semi-structured interviews with 19 members of nonprofit organization, *DiverseCS*, to better understand how organizational leaders enable proto-institutionalization. Importantly, DiverseCS is an organizational community that contributes to the innovation of diversity practices in higher education. I chose to sample approximately 19 organizational members using snowball sampling. I reached theoretical saturation when interviews no longer informed emergent theory (Charmaz, 2006); I further discuss these issues below. Although not a formal source of data for my study, I obtained access to organizational documents to provide greater context to the in-depth interviews. I also attended an annual meeting of DiverseCS in 2017.

DiverseCS aims to increase female and racial/ethnic minority participation in computing higher education among undergraduates by supporting undergraduate student led engagement with local community organizations, schools, and universities. DiverseCS contains members from 43 colleges and universities in the United States that lead DiverseCS chapters at their respective organization. These colleges and universities are diverse, representing large public and private research universities, small liberal arts colleges, women's colleges, historically black colleges and universities, and community colleges. A Senior leadership team coordinates communication among each DiverseCS chapter. The senior leadership team also hosts an annual physical meeting. Furthermore, a diverse organizational community, consisting of for-profit and non-profit organizations,

supports each college and university. Organizational support may include financial donations, sharing personnel, training university members, among other forms of support with the aim to foster the development of new diversity practices.

I conducted 19 interviews with individuals in leadership positions in DiverseCS, 18 which were analyzable, in order to understand their actions preceding key events and their understandings of those actions and events. One interview was not analyzable due to issues with the recording software. This sample size is consistent with the recommendations by qualitative scholars for adequate sample sizes for grounded theory research designs (see Charmaz, 2006) and is well above the typical sample size necessary for theoretical saturation (Guest et al., 2006). Interviews are with the individuals, typically professors, who lead the DiverseCS program at their respective college or university. For inclusion in this study, organizational members must interact with a variety of other actors through collaborative relationships; therefore, the interview participants actively construct social networks between their university or college and other organizational actors. Interview questions include general queries regarding the interviewee's professional interest in DiverseCS, such as, "How did you come to be involved in DiverseCS?" Questions also ask about how participants construct social networks, such as "How do you identify collaboration partners when creating a new diversity practice?" Finally, questions also seek to uncover participants' discursive strategies, particularly regarding the use of narratives, to facilitate collective sense-making of uncertain organizational events and situations. For the full interview protocol, please see Appendix A.

My sample includes substantial diversity among participants across various demographic and organizational attributes. Of the 18 analyzable interviews, 10 were with female participants. Tenure with DiverseCS ranged between 1 year to 12 years among the participants. Participants also held various ranks with their respective universities; specifically, the sample includes lecturers, assistant professors, associate professors, full professors, and university administration. .Interview participants primarily held positions in the southeastern United States, however, a few participants held positions in the midwestern United States. Finally, university type was diverse, including public research universities, liberal arts universities, and historically back universities.

I interviewed participants over the telephone and recorded our conversations. The duration of the interviews was typically an hour. Interviews were transcribed and converted into a word documents for open, axial, and theoretical coding (Charmaz, 2000) on which I elaborate below. There were 262 pages of interview transcriptions in total. I have used pseudonyms for each individual and de-identified particular places and people to preserve confidentiality.

I also obtained internal organizational documents. Organizational documents include annual evaluation reports, internal memos, and internal resource packets. A senior DiverseCS leader constructs an annual evaluation report that aggregates information for each member college and university, highlighting, strengths, weaknesses, and events during the reporting period. Internal memos often contain candid constructions of organizational reality that many public-facing documents conceal. Finally, internal resource packets allow me to better understand the research context by providing information on each emerging proto-institution. The DiverseCS senior

leadership team compiles promising and potential best practices to disseminate among constituent organizational members. These resources provide an important source to contextualize the qualitative research and further customize the in-depth interviews.

Accordingly, I review all documents that I am able to obtain prior to the interviews, although I do not formally analyze these documents. I use grounded theory methodology to analyze the interview transcripts.

Qualitative analysis

Contemporary approaches of grounded theory (Charmaz 2000, 2006) allow researchers to use extant theory to guide the analysis and emergent theory. I gave particular attention to theoretical concepts from the innovation and complexity science literatures such as "tags," narratives, and collaboration. Slight deviations may occur from the interview protocol to further explore the theoretical concepts of interest. Analysis follows three stages: open coding, axial coding, and selective or theoretical coding. Open coding requires the development of in vivo categories that describe each line of the data and when possible uses the participants' own phrases and words (Strauss and Corbin, 1998). Where in vivo codes did not accurately capture my interpretation of a line or phrase I wrote descriptive codes, elaborating on my interpretation of the line or phrase. I used NVivo software to record the open codes. During open coding I wrote theoretical memos describing emerging patterns from the data, while moving between emergent categories and the data. Moving between my understandings of the emerging categories and data collection adheres to the constant comparative criteria of grounded theory that permits the researcher to follow theoretically interesting or meaningful areas of inquiry (Charmaz, 2000, 2006). I continued line-by-line in vivo open codes until I felt that I

reached theoretical saturation or when new interviews did not result in the creation of new open codes, after which I began to code larger passages using a combination of in vivo codes and descriptive codes.

I coded 675 open codes, using both in vivo coding by using participants' actual phrases as the codes and descriptive coding. After approximately 12 interviews I reached theoretical saturation, as recurrent categories became commonplace. At this point, I began to rely more on descriptive coding, rather than in vivo coding. The descriptive codes contain my interpretations of the data. For example, the open code "bowling nights – community" describes a participant's account of how they seek to increase group cohesion among their DiverseCS students by hosting a bowling night once per semester.

Following open coding, I began axial coding to group major categories and sub categories; during this process I developed lengthy and descriptive accounts of the emerging categories (Strauss & Corbin, 1998). I categorized the open codes by identifying categories that are common to several open codes. I continued this process in an iterative manner until the open codes fit into thematic groups. I also continued to write theoretical memos during axial coding to both help facilitate the construction of higher-order categories and to record my thoughts and observations regarding theoretical relationships among the emerging categories. I used these theoretical memos extensively during the final stage of coding, selective coding.

I began selective coding by specifying the relationships among the axial categories (Strauss & Corbin, 1998) in order to "collapse them into higher order theoretical relationships" (Beck & Plowman, 2014, p. 1237). During selective or theoretical coding, I arranged the categories in accordance to theoretical relationships that

emerge from the data while adhering to the organizational timeline regarding

collaboration and the creation of novel diversity practices. The resulting theoretical

framework is then suitable for theory testing studies through quantitative analysis. I also

performed negative case analysis at this stage to address other possible explanations of

the data and to ensure theoretical saturation. Negative case analysis forces the researcher

to use the resulting theoretical model to explain extreme cases or cases that fall outside

the boundaries of the model, clarifying the scope conditions of the theoretical model

(Tracy, 2013).

Qualitative quality

   This study adheres to several criteria regarding quality for qualitative research

(Lincoln & Guba, 1985, 2000; Tracy, 2013). Importantly, while validity and reliability

are readily understood within the post-positive paradigm, these concepts do not as readily

apply to an interpretive paradigm (Tracy, 2013). Addressing this concern, Golafshani

(2003) contends that within the qualitative research paradigm, validity and reliability

correspond to "trustworthiness, rigor, and quality" (p. 604). Moreover, qualitative

scholars argue that a determination of a study's quality cannot be made after the

completion of data analysis, but rather the research design must incorporate quality

practices throughout data collection, analysis, and interpretation (Golafshani, 2003;

Lincoln & Guba, 1985, 2000; Tracy, 2013). Therefore, data collection, data analysis, and

the presentation of findings adhere to several practices that promote trustworthiness and

rigor in qualitative research designs. I discuss these practices in the following paragraphs.

   To ensure trustworthiness, I adhere to Lincoln and Guba's (1985, 2000) four

criteria for establishing credibility of findings. First, through both interviews with

participants and during open and axial coding, I generate a 'thick description' or a

detailed, descriptive account of the variables and context of interest. Moreover,

theoretical memos written during data analysis further enhance the richness of the data.

The resulting theoretical model therefore represents a vast amount of data. Second, I

triangulate the qualitative data by comparing events, activities, and narratives within the

DiverseCS organizational documents to the interviews that the participants provide to

better contextualize and understand the interviews. I read the DiverseCS organizational

documents and wrote theoretical memos that contain my understandings of the

documents, key organizational events, and potential theoretical relationships. Such

documents provide additional insights into the phenomenon of interest and provide

checks of credibility within the research design itself. Third, triangulation and the

inclusion of research participants into the sample, representing diverse backgrounds and

experiences (i.e. organizational member at a community college, organizational member

at an elite private university), adheres to Lincoln and Guba's (1985) recommendation of

multivocality – the representation of multiple voices. Multiple voices are important since

diverse perspectives increase the likelihood that the data will contain both typical cases

and extreme cases that may occur rarely but are theoretically meaningful.

Finally, I use member checks whereby the researcher shares results and

theoretical conclusions with participants during the iterations between data collection and

data analysis to gain a greater understanding of the data and to ensure that my

interpretations remain grounded to the data. Member checks provide an opportunity for

research participants to contribute to the data analysis process and to facilitate collective

sense-making. Tracy (2013) notes that research participants input may disagree with the

researcher's interpretation and conclusion; disagreement does not, however, necessarily indicate that the findings or conclusions are untrustworthy, since disagreement can occur for numerous reasons. I conducted three formal member checks and also included member check questions during the last six interviews. Member checks led to the revision of several axial codes to better reflect the goals and activities of DiverseCS. Specifically, member checks contributed to my understanding of outreach events led by DiverseCS groups.

As mentioned in the discussion of trustworthiness above, practices and standards of quality must be included in the research design of qualitative research. Tracy (2010, 2013) discusses rich rigor, sincerity, ethical considerations, and meaningful coherence as pertaining to the conduct of the study; moreover, these concepts correspond to Golafshani's (2003) description of rigor. This research contains data from multiple sources (i.e. interviews, organizational archives, network data), ensuring that appropriate conclusions regarding the theoretical phenomenon of interest can be made. Moreover, as previously discussed, data analysis is iterative and follows several distinct stages. Through the use of theoretical memos, the researcher's perspectives and interpretations of the data become known and serve as a control mechanism to prevent the imposition of a priori beliefs on the data and conclusions, adhering to Tracy's criteria for sincerity (Tracy, 2013). I consider ethical obligations to the participants of the study and the broader scientific community by obtaining institutional review board (IRB) approval of the research prior to data collection. Additionally, I ensured that participants are at all times aware that their participation is voluntary and that the interview does not cause undue stress to the participants, which should not be a cause for concern since the

interview protocol does not ask about issues that are generally considered private or sensitive. Finally, the theoretical model that emerges from the data is meaningfully coherent by clearly stating scope conditions, articulating theoretical relationships in a logically consistent manner, and connecting the theoretical model with the extant literature.

No qualitative study closely adheres to every quality criteria (Tracy, 2013). The decision regarding which criteria to include is at the researchers' discretion and often depends on the end goals of the research. Therefore, this study does not completely adhere to the criteria of resonance. According to Tracy (2013), resonance refers to two concepts – transferability and aesthetics. Through the establishment of trustworthiness of findings and meaningful coherence, the study elucidates abstract variables and characteristics of those variables that readily transfer to empirical contexts other than the field of computer science. This research will not strive to maintain aesthetic standards that would compromise clarity and understanding of the findings. Such a decision relates to the "balancing act" of qualitative criteria.

Finally, Tracy's (2013) eight "big tent" criteria for qualitative quality also provides recommendations for general qualitative designs. From both an empirical and a theoretical perspective, this study meets Tracy's (2013) goals of worthy topic and significant contribution. The empirical findings from this study concerning how to promote diversity practices in computer science education are timely given the spate of research that contends that college classrooms and organizational payrolls are homogenous in regards to race and gender (see Stainback et al., 2010). Moreover, the results of this study should be of significance and interest to organizational scholars,

social scientists, computer scientists, business leaders, and policy makers, as the diversity

crisis in computer science education represents a grand challenge, which affects and

concerns numerous stakeholders (see George et al., 2016). The resulting theoretical

model also makes a significant contribution to extant literature by integrating nascent

proto-institutional research with complexity science scholarship and further refine the

methodological tools to study this phenomenon. Although these literature streams have

developed independently of each other, there is much overlap between them and a

significant opportunity to advance scientific knowledge both theoretically and

methodologically.

CHAPTER 4: QUANTITATIVE RESULTS

Descriptive results

The web crawler identified 4409 unique websites. Upon review of each of the 4409 websites, I determined that 251 websites were not be relevant to issues germane to diversity in computer science education, leaving a final sample of 4158. The final sample consists of the digital field of diversity issues in computer science education. Figure 1 displays the digital field.

The final sample contains a single component, indicating that the majority of websites in the sample share at least one link with another website. Within the digital field there are 4864 unique links among the websites. Additionally, there are 53 isolates in the sample. Isolates share no connections with another website and occur as the web crawler collapses websites into groups based on their domain name.

As bi-directional or mutual hyperlinks between websites have been previously taken to indicate collaborative relationships among organizations (Powell et al., 2014), this is an important aspect of any hyperlink network. In this sample, there are 85 mutual hyperlinks among the total 4158 websites. Although the quantitative data and analysis cannot identify the true number of collaborative arrangements, it is unlikely that among the 4158 websites identified that only 85 collaborations exist among them.

The digital field surrounding diversity issues in computer science education is diverse, encompassing websites such as personal blogs, non-profit webpages, academic and industry conference webpages, educational resources, social media links, corporate webpages, news reports, and links to commercial product information. For example, the digital field includes the website, *https://software.intel.com/en-us/blogs/2015/07/28/with-*

stem-education-women-can-create-both-technology-and-their-own-futures, which is a

blog post on Intel's product development support forum. This particular blog post

describes how women can achieve substantial success in science, technology,

engineering, and mathematics, while also providing hyperlinks to various programs and

corporate initiatives. In fact, the keyword, *blog*, is found on 424 websites in the digital

field, demonstrating the unique forms of organizing found in a virtual context (Powell et

al., 2016). Academic and industry conferences are also prevalent in the digital field,

returning 64 websites that contain *conference* as a keyword. For instance, the

International Conference for Functional Programing is among the dozens of conferences

in the final sample of websites. Taken together, the digital field consists of a diverse array

of actors that engage in virtual interaction during proto-institutionalization.

Before turning to network complexity, I further investigate the descriptive

properties of the digital field, specifically network density. Network density, as measured

by the ratio of actual links in the network to all possible links in the network, is 0.0002 or

less than 1%. In other words, the network contains less than 1% of all possible links

among websites. This finding for network density indicates that the network is sparsely

connected, consistent with small world network topography (Watts, 1999).

Additionally, Figure 1 reveals the overall topography of the digital field.

Approximately 7 hubs or communities are present within the network. Unsurprisingly,

each of these communities are also seed websites that were chosen due to their central

position in regards to computer science education. Figure 2 presents the digital field using

a visualization that highlights the hub structure within the network. Accordingly, Figure 2

demonstrates how the majority of websites within the network reside within hubs or

communities, indicative of a scale-free, complex network. From this perspective, the

network visualizations and the descriptive measures of the network suggest complexity

by revealing a robust structure of local communities within the digital field.

Influence in the digital field

Another important set of measures for social network analysis concerns the

identification of important nodes in a network. In the digital field, certain websites may

be able to exert more influence than others. For example, a website that connects to a

substantial number of other websites or a website that spans two large communities also

likely shapes how an individual accesses information in the digital field. I use several

measures to describe the degree of influence within the digital field. Specifically, I

measure the digital field's eigenvector centrality, PageRank, and HITS. Each of these

measures provide insight into the degree of influence within the digital field by

examining different structural aspects of the network. I will now detail each of these

measures.

To investigate this phenomenon, the first measure I report is the eigenvector

centrality distribution of the websites in the digital field. The eigenvector centrality is an

important measure because it takes into account both a website's hyperlinks to the other

websites in its ego network and also the centrality of those other websites (Borgatti et al.,

2013). In other words, it not only matters who you know, but also who those individuals

know. The measure for eigenvector centrality ranges between 0 (e.g. little importance)

and 1 (e.g. significant importance). In the digital field the eigenvector centrality for

Code.org is 1, indicating that Code.org connects to other influential websites. To

illustrate, Code.org shares a hyperlink with NCWIT.org, which itself has an eigenvector

centrality measure of 0.65. In contrast, constructionstem.org hyperlinks to NCWIT.org

and yet has an eigenvector centrality measure of 0.02, indicating that

constructionstem.org is not an influential website in the digital field of computer science

diversity practices. Indeed, constructionstem.org is the website for *Construction Forum*, a

professional association of St. Louis' construction industry that supports academic

research and construction relevant K-12 education. *Construction Forum*, while

advocating for diversity issues in general, does not take a primary interest in computer

science education, which contributes to a low eigenvector centrality measure in the

digital field of diversity issues in computer science education.

　　　　To illustrate influence in the digital field, Figure 3 presents the distribution of the

eigenvector centralities of each website in the digital field. The majority of websites have

an eigenvector centrality measure close to 0, which is consistent with the hub structures

present in Figure 2. There are a large number of websites like constructionstem.org that

reside in the periphery of the digital field. Such organizations possess goals that may

address diversity in another social context or may advocate for computer science research

without championing diversity. Organizations like NCWIT, the National Center for

Women & Information Technology, are central to the digital field and possess a high

eigenvector centrality. Of particular importance, due to the large discrepancies among the

eigenvector centralities the scale of the graph is very large, making it difficult to interpret

the graph. In sum, influence in the digital field concentrates among only a small number

of actors.

　　　　To further understand the distribution of influential nodes within the digital field,

I apply the PageRank algorithm (Brin & Page, 1998). And the HITS algorithm

(Kleinberg, 1999). Both the PageRank and the HITS algorithms attempt to capture the influence of a particular node in a network and were developed with the specific purpose of understanding hyperlink data. To better illustrate the macro-structural properties of the digital field, I present the distributions of each website's PageRank and HITS measures, respectively. Also, each of these measures uses the directed network structure of the digital field, instead of the undirected network. Brin and Page's (1998) PageRank algorithm provides a probability distribution that estimates the likelihood that a person that randomly clicks on hyperlinks will arrive at a particular page. Figure 4 presents the PageRank measures of the digital field. Figure 4 demonstrates that the majority of websites have a low PageRank measure, indicating that there is a low probability that someone randomly clicking on hyperlinks will find any of the websites in the digital field. Nevertheless, there is a low degree of variation among the individual websites' PageRank values. To further investigate the distribution of influence in the digital field, I use the HITS measures that capture the hubs and authority within a network. For this measure, hubs refer to the value of a focal website's hyperlinks while authority refers to the value of a focal website's content. Figure 5 presents the hubs distribution and Figure 6 presents the authority distribution. Both hubs and authority display consistency with the PageRank distribution. Again, due to the large range of values the graphs conceal nuances among each website. The overall trend of each graph is important, that is only a few websites exert significant influence in the digital field, whereas the majority of websites wield very little to no influence. There are some websites that are important in the network, while the majority of websites do not possess significant value according to their hyperlinks or content.

Taken together, the preceding measures of the network structure of the digital field demonstrate that the digital field is large and contains many websites that are only tangentially relevant to the issue of diversity within computer science education. The network possesses a low density of hyperlinks in comparison to the number of websites within the sample and contains several websites that exert significant influence over the entire network. Websites such as code.org are central to the digital field. I further investigate the network structure of the digital field by applying several measures of complexity.

Measures of complexity

I now turn to the three measures of the network complexity index (see Wang et al., 2011). Specifically, the network complexity index consists of the degree distribution, the average path length, and the average clustering coefficient of the network. To indicate network complexity, the degree distribution should resemble a power-law distribution, the average path length should be relatively short, and the average clustering coefficient should be relatively large (Wang et al., 2011; Watts, 1999). Together these measures provide insight into whether the hyperlink network provides individuals with access to information that crosses multiple boundaries, providing the necessary conditions for emergence (Miller & Page, 2007). I first discuss the degree distribution in the digital field.

A node's degree refers to the total number of links a node shares with the other nodes in a network (Barabási & Albert, 1999). In the context of the digital field, a website's degree is the sum of the hyperlinks that connect other websites to the focal website. The average degree of websites in the digital field is 2.26. On average, each

website connects to approximately two other websites. In order to examine network complexity, the distribution of all degrees in the network must be plotted. Specifically, network complexity may be inferred when there are only a few nodes that are highly connected, while the majority of nodes possess a low degree, adhering to a power-law distribution (Wang et al., 2011). Figure 7 displays a plot of the degree distribution of the network. Figure 7 that the degree distribution does resemble a power-law distribution, consistent with network complexity. As power-law distributions are difficult to observe due to the extreme values in the distribution, I also plot a log-log graph below. In particular, there are 25 websites in the sample that have a degree of 10 or greater, while 3,639 websites have a degree of 1 or 87.5% of the sample. Such a large disparity in reference to degree among the websites in the sample suggests the presence of network complexity.

The website that has the highest degree in the digital field is code.org. Code.org is a non-profit organization that seeks to increase gender and minority representation in computer science classrooms throughout the United States. Code.org has a degree of 746. Specifically, Code.org's indegree measure is 700, demonstrating that 700 other websites in the digital field contain at least one hyperlink to code.org. In contrast, Code.org's outdegree measure is 46. Figure 8 displays the ego network of code.org. For clarity, websites within Code.org's ego network with a degree of one are arranged around code.org (center), while websites that connect to more than one website are arranged to the left side of the graph. To better understand the network structure of Code.org's ego network, I removed all websites with a degree of 1 and labeled each website with a degree over 3, Figure 9 presents this visualization and also provides insight into the

composition of the digital field by highlighting the diversity of actors within the field.

Code.org shares connections with other non-profit organizations such as exploringcs.org,

k12cs.org, www.madewithcode.org, and cahsi.cs.edu. Other websites such as

www.businessinsider.com, www.google.com, and philanthropynewsdigest.com also

share connections with code.org. Finally, Figure 9 also demonstrates the central position

of social media in digital fields, as LinkedIn, Twitter, Instagram, and YouTube each

connect to code.org.

In addition to code.org several other websites have a high degree distribution,

such as ncwit.org and hourofcode.com. Nevertheless, while figure 7 suggests that a

power-law distribution likely characterizes the distribution of degrees in the digital field,

further testing is necessary (Clauset et al., 2008). Clauset and colleagues (2008) contend

simply examining the shape of an empirical distribution does not provide sufficient

evidence of a power law distribution, providing a series of steps to address the issue.

Following the implementation of Clauset and colleagues (2008) algorithm the degree

distribution fits a power-law function of the following form: $f(x) = x^{-3.3}$. Figure 10 plots

the empirical data (points) and the estimated power-law function (dotted lines) on log-log

axes. Figure 10 demonstrates that the empirical data departs significantly from the power-

law function. Moreover, the Kolmogorov-Smirnov goodness-of-fit statistic D is 0.019

and has a p-value that does not differ significantly from 0, indicating that the degree

distribution does not adhere to a power-law function. Therefore, while the degree

distribution appears to follow a power-law function (see Figure 7), it does not actually

follow a power-law function.

Additional measures of network complexity are the clustering coefficient and the average path length. The clustering coefficient summarizes the homogeneity of connections within a network, whereas the average path length describes the degree to which websites in the network are connected to each other. In order to interpret whether the digital field adheres to these measures of complexity, I compare each of the measures to a those of a random graph. The clustering coefficient is 0.263 (random graph = 0.025), which is large. Such a large clustering coefficient indicates a small world network. However, the average path length or the average number of steps required to move across the entire network is 3.64 (random graph = 2.10), which is high. In other words, one must pass through approximately 4 websites on average to move from one end of the digital field to another. In contrast to the high clustering coefficient, a high average path length, in comparison to a random graph, does not suggest network complexity.

To further investigate the network topography and the degree of clustering within the digital field, I use Blondel and colleagues (2008) algorithm for community detection, commonly known as the Louvain method. The Louvain method is a greedy algorithm that optimizes the number of nodes within a potential community based on the ratio of the density of links within the potential community to all those within the network. The algorithm continues in an iterative manner until it optimizes the community structure of the network (Blondel et al., 2008). The Louvain method detected 100 distinct communities in the sample. There are 12 large communities in the digital field, containing 91.7% of the websites in the digital field. Figure 11 displays these communities, using different colors for nodes in each community. Communities that represent at least 3% or more of the digital field are uniquely colored. Importantly,

communities that comprise less than 3% of the digital field are gray. Crucially, there are

distinct connections among each of the major communities, indicating pathways of

communication between communities. This finding may be particularly relevant for those

actors that span two disparate systems of meaning, which the qualitative data will address

in greater detail.

Figure 12 plots the size of each of the twelve communities. The size of a

community refers to the quantity of websites within that community. The largest 12

communities range in size from 572 websites to 162 websites. Of the 12 largest

communities, approximately, 5 contain 400 websites and another 5 contain about 200

websites each. Interestingly, the structure of many of the largest communities is that of a

single website and its ego network. For example, code.org and the majority of its ego

network make up the largest community (purple). This community structure suggests that

the information within the digital field is partitioned by its relational structure via

hyperlinks and resides within well-defined hubs. Nevertheless, such a robust community

structure, as indicated by the size of the communities, further illustrates significant

clustering within the digital field.

Supplemental analysis

As 21 of the 23 seed websites are among the websites that have the highest degree

in the sample, I conducted a supplemental analysis to investigate the efficacy of the web

crawler methodology for organizational research. Specifically, the overrepresentation of

the seed websites among the highest degree websites in the sample may be the result of

the web crawler accurately capturing the structure of the digital field surrounding the

issue of diversity in computer science education. From this perspective, the selection of

the preceding 23 seed websites by subject matter experts truly reflects the most important

websites in the digital field. On the other hand, the findings from the web crawler could

be a result of the methodology, rather than the product of the digital field. From this

perspective, the web crawler may oversample the hyperlinks on the seed websites. The

web crawler follows hyperlinks until either there are no new hyperlinks or until an

arbitrary number of links have been followed. For this study the web crawler stopped

following new links after the identification of three internal hyperlinks on a webpage. A

stopping rule is important because without such a rule, the web crawler may run

indefinitely due to high degree of connectedness of the World Wide Web (Ackland,

2013).

To test each of the preceding possibilities, I conduct a supplemental web crawl. I

use 10 websites that I identified from the primary web crawl. Table 2 presents the list of

seed websites for this supplemental analysis. I chose websites that had both a low degree

and appeared to advocate for diversity initiatives within computer science education,

rather than playing a tangential role at the field's periphery. Following the identification

of the 10 seed websites, I used the web crawler to collect a new sample of hyperlinked

webpages.

For this supplemental analysis, the web crawler identified 865 hyperlinks among

915 unique websites. Figure 13 presents the visualization of this network. Interestingly,

the structure of this network is similar to that of the primary network (see Figure 1).

There are several hubs or repositories of hyperlinks in this sample. Moreover, the

websites that are hubs corresponds to the seed webpages. Table 3 presents the top 10

websites in this supplemental analysis by degree. Of the 10 seed websites, 9 are among

the websites with the highest degree. Approximately, 85% of the websites in the sample have a degree of 1, whereas approximately, 3 % of the sample has a degree of 2. Importantly, the seed websites in this supplemental analysis were websites that have a low degree in the primary analysis. For example, www.acm.org has a degree of 9 in the primary sample, as reported above, while the degree for www.acm.org in the supplemental sample has a degree of 285. The other websites in the supplemental analysis follow a similar pattern.

The supplemental analysis suggests that the web crawler oversamples the seed websites, while also under sampling the other websites in the sample. This artifact of the web crawler is likely to significantly alter the results of the network analyses. Although it is beyond the scope of this research, further analyses are needed to better understand how web crawler technology may be used in management research.

Notwithstanding methodological concerns, the quantitative results demonstrate that the digital field contains a diverse array of organizations and actors, including conferences, professional associations, for-profit organizations, non-profit organizations, blogs, and social media accounts. Additionally, influence and authority in the digital field resides within only a select few websites, arranged in a hub structure. Wang and colleague's (2011) complexity index suggests that the digital field exhibits some properties of a complex network. To better understand the interactional processes that underlie the structure of the digital field and the action that occurs in the digital field, I turn to the results of my qualitative analysis.

CHAPTER 5: QUALITATIVE RESULTS

Qualitative analysis findings and interpretations

While the quantitative network analysis illustrates the structure of the digital field, network analysis alone cannot explain action within the digital field. In particular, although the digital field exhibits properties of a complex network, questions arise regarding how actors' actions contribute to the ongoing structuration of the digital field and also how the digital field shapes individual action. Research questions 2-4 address these concerns. In this manner, the qualitative findings illustrate how individual actions contribute to the formation of the structural network properties of the digital field.

Table 4 presents the axial codes of my grounded theory analysis. Please note that the discussion section presents the results of theoretical coding, as well as the integration of the quantitative and qualitative results, by illustrating models of emergence and leadership of proto-institutionalization in a digital context.

I present the findings from the interview data in several sections. First, I address research question 2 regarding how inter-organizational relationships form in the digital field. This section emphasizes how collaborations form between DiverseCS and their partners for community outreach. I then discuss how organizational leaders engage in both network enhancing strategies and discursive strategies, specifically emphasizing the use of narratives among DiverseCS leaders. I also discuss the importance of community among organizational members and how leaders' actions facilitate the formation of a coherent identity. Finally, I discuss how the use of information technology and interaction with the digital field enables emergent phenomenon. I embed the findings

pertaining to each research question into the overall narrative account of interaction among DiverseCS members.

Hyperlinks and collaboration

Digital fields coalesce around broad organizational or societal issues that require actors to coordinate activity, combining complementary skills and knowledge to address the focal issue prompting the formation of the field. From this perspective, collaboration represents a crucial strategy for efforts of proto-institutionalization in digital fields. Hyperlinks that connect two websites constitute the basic element of the digital field. Prior research suggests that bi-directional hyperlinks represent collaborative relationships among organizations. In contrast to these expectations, in-depth interviews with DiverseCS leaders, illustrates that hyperlinks serve multiple purposes. While DiverseCS leaders occasionally place a hyperlink on their website to signify an inter-organizational collaboration, they also use hyperlinks to provide access to information about diversity issues or share educational resources with others. Hyperlinks also confer status to other organizations that hold prominent positions within the digital field. Below I describe the multiple uses of hyperlinks among DiverseCS leaders.

For leaders of DiverseCS, hyperlinks often allow them to guide others to information concerning diversity issues in computer science education. In this manner, hyperlinks grant access to webpages that demonstrate an organization's efforts to address issues of diversity. Webpages contain descriptions, photographs, and videos of past organizational activities, such as sending college students to host a programming workshop for a local middle school's computer science class. DiverseCS leader, Susan, states: "On my website I'm ... It's mostly like something that's ... It's mostly really just

show off what my chapter doing, so somebody from outside comes and looks at it they can see ..." Hyperlinks preserve an organization's past actions, while also articulating future goals. Hyperlinks, therefore, promote organizational learning by disseminating successful actions for the consumption of other organizational actors, such as other non-profit organizations, for-profit organizations that seek philanthropic opportunities, or external evaluators of diversity practices.

DiverseCS leaders view information on websites as a dynamic component of inter-organizational relations, rather than a static repository of knowledge. When DiverseCS leaders use hyperlinks to store information and organizational knowledge, they do so to improve intra-organizational and inter-organizational interactions. Specifically, DiverseCS leaders use hyperlinks to create repositories of organization-specific knowledge. These hyperlink repositories, similar to the hubs of hyperlinks shown in the quantitative analyses, affect interaction within the organization. For example, DiverseCS leaders often use their websites to capture tacit organizational knowledge and routines. When a new member joins DiverseCS they must view the website to better understand how to conduct their work and how their tasks contribute to the organization's primary goal of diversity. Accordingly, websites frequently become hubs of information about diversity issues and practices. In discussing their website, one leader, Bobby, states:

> For the main website I always took it from the perspective of what would be valuable to somebody looking for something and thinking we have that information. So anything related to the operations of DiverseCS was important to be on there, so how does an academic liaison request funding, that should be on the website. How do you get a DiverseCS student group going, that should be on the website. How do you get involved with weekly meetings, that should be on the website.

Bobby's statement reveals how webpages reduce the uncertainty that accompanies the ambiguity of proto-institutionalization. As such, the practices of DiverseCS may also be confusing for new members, including new leaders, therefore, the website clarifies complicated tasks and makes sense of organizational tasks. For instance, Steve, a DiverseCS leader at a private college in the Southeastern U.S., uses YouTube videos to translate tacit knowledge into overt organizational practices for his student members. In this manner, webpages do not replace face-to-face interaction, but rather they support the functioning of important organizational activities.

While hyperlinks do not always signal collaboration between DiverseCS and other organizations, hyperlinks may help to facilitate the creation of a new collaborative arrangement or support the functioning of an existing collaboration. Tasks and goals that address issues of diversity may be difficult to communicate through face-to-face interaction or through a solely technological interface, such as email. The predominant model of promoting diversity within DiverseCS is for student members to conduct outreach events with local primary schools or community organizations. To reduce uncertainty among collaboration partners, DiverseCS leaders often choose to strategically use their websites to create repositories of information that their collaboration partners could use to understand expectations regarding the coordination of tasks and meaning making. For instance, Diane states, "A reason to put a hyperlink on our page would be to connect folks to the organization that we're going to work with so we all know more about, maybe, the mission of that particular community organization..." Diane's comment illustrates how hyperlinks provide useful information about collaboration partners that allows each participant to function in the collaborative system effectively.

Finally, in addition to serving as a gateway to information, organizational members also use hyperlinks to confer status to other organization's websites in the digital field. Individuals express deference when they place a hyperlink to another website on their organization's website. Organizational leaders often maintain websites for others. In this manner, organizational websites exist for the consumption of other field members. For example, Tim jokingly states "it's mostly just for outside people. It, essentially, looks professional because we have to convince mothers that, and fathers, to part with their children, right? So that's not really for us." Hyperlinks, therefore, often reflect what organizational members find valuable in the context of their digital field. From this perspective, DiverseCS members create hyperlinks, in part, to highlight their formal relationships with corporate sponsors that provide them with material resources, as such relationships attract substantial attention and adulation among DiverseCS leaders and cedes DiverseCS legitimacy among other non-profit organizations that advocate for diversity. Accordingly, DiverseCS chapters that receives resources from corporate sponsors frequently include hyperlinks to those sponsor's websites on their own. This type of hyperlinking activity further contributes to the formation of the digital field, as demonstrated in the quantitative analysis. Specifically, a DiverseCS chapter's website that includes several hyperlinks to corporate sponsors will engender a hub-like or fan shaped network pattern of hyperlinks radiating outward from the focal website.

Each of the preceding motivations for hyperlinking seek to spur interaction between the digital and the physical. Indeed, an interactive emphasis on hyperlinking has been present in DiverseCS since its founding. Founding leaders, responding, in part, to institutional pressures from the National Science Foundation, sought to use hyperlinks as

a mechanism to circulate emergent diversity practices and outreach events to a broad audience. The National Science Foundation exerts a coercive pressure on DiverseCS, requiring adherence to various rules that govern their activities; noncompliance risks funding and legitimacy. Accordingly, the National Science Foundation requires DiverseCS to disseminate their diversity practices. Due to this pressure, organizational leaders use hyperlinks as a method of reaching a wide audience, demonstrating their activities and propagating their institutional innovations that address issues of diversity.

Nevertheless, cultivating an organizational website and engaging in strategic hyperlinking to further organizational goals requires skill. DiverseCS leaders acknowledge that he skill to blend social and virtual interaction is rare. Many DiverseCS leaders did not use hyperlinks or did so in a limited manner. For them, overseeing their organization's website is not one of their primary responsibilities or they may simply lack the time to develop and update their organization's website. Due to time and resource constraints, a leader may place a hyperlink on their website to rapidly deliver information to their stakeholders, such as students, other organizational members, or sponsors. For example, Jane states:

> I mean its so bare bones there's hardly anything on there. It was basically used as an… to provide… so that students could know where to apply. And that's about it. It is not... I don't think it looks good enough to kind of use as a showcase for our organization but more like an oh I need something really fast let me just throw something together. And you know ... Like most things that get thrown together its three years later and its still there but it doesn't look any better. So... No... I haven't given much thought...

Jane and other leaders often do not employ virtual interaction or digital resources to engage in proto-institutionalization. Instead, these leaders use online resources reactively, making use of them only when doing so will further aid face-to-face collaborations or relationships. Effective websites require a blend of technical prowess to write the

programming code that supports the website and creativity to write and illustrate an appealing virtual space, necessitating a substantial investment of resources and skills.

According to the leaders of DiverseCS, hyperlinks serve a multitude of purposes. A leader may wish to highlight crucial information, such as a recent outreach event, detailing the context of the event (e.g. elementary school) and what activates occurred during outreach (e.g. computer programming competition). In this manner, other non-profits may be able to adopt attractive events for their own organization, thus leading to the diffusion or proselytization of proto-institutions (Powell et al., 2016). Hyperlinks may also confer status, denoting the actors which organizational leaders perceive as being central and important to the digital field. Finally, hyperlinks are often hastily put together so that they function, yet do not receive much thought afterwards and often fall into disrepair. One leader lamented that they had devoted so much time to creating a website only for it to become underutilized and become outdated for the past several years. In this manner, no single reason describes hyperlinking actions by organizational leaders. Nevertheless, hyperlinking does often spur further interaction, especially in regards to inter-organizational collaborations.

Collaboration and network building

The following sections address research questions 3 and 4. Although the motivation to use hyperlink to other websites varies, the preceding results only partially address how the digital field facilitates the formation of inter-organizational relationships. The second category to emerge from the qualitative data is that collaboration between DiverseCS leaders and other organizational actors occurs primarily in a local context, where each participant in the collaborative arrangement is able to meet face-to-face.

Indeed, many collaborations occur when a community organization initiates contact with a DiverseCS leader, expressing a need for a specific educational workshop or activity. DiverseCS leaders rely on their personal and professional networks to identify collaboration partners, using these pre-existing relationships to circumvent the costs of partner search and the resources necessary to establish trust among strangers. Due to the activities of DiverseCS, collaborations usually occur on a relatively small scale, typically in the same city or town where each collaboration partners resides, as DiverseCS advocates for diversity through community outreach.

Collaboration often occurs in local contexts, primarily due to how DiverseCS seeks to innovate proto-institutions. Proto-institutions that seek to diversify computer science education usually consist of outreach events where DiverseCS leaders and student members host educational activities, classes, or workshops with individuals in their own communities. Outreach events occur among community organizations, schools, and non-profit organizations. Although the digital field does facilitate the formation and functioning of such arrangements, there is a substantial amount of work that must be undertaken in a physical, face-to-face context. In this manner, the task prompts the formation of the local collaborative arrangement.

The most common form of collaboration occurs between a DiverseCS chapter and a local primary or secondary school or a non-profit organization. Through community outreach events, DiverseCS sends one or more student members to the partner organization to conduct a workshop with school children. Workshops may include constructing and programing a robot using Lego's Mindstorm products or putting together a small computer with RaspberryPi. Leaders of DiverseCS describe a need in

their local communities for computer science and computing education to complement their services. Diane underscores this point: "When it comes to community organizations and the school systems, they're desperate for anyone who will help them introduce tech to the students they serve. You generally don't have to look too far." This need often arises from schools seeking opportunities to enrich their students' educational experience or supplement their own course offerings. For instance, Tim describes: "I have not been out looking for them, but they have contacted me in a couple of cases. We did collaboration with State Tech on their Google Grad, for three semesters. And that was called, Rise Up for CS. And it was outreach to high school students taking the AP CSA exam." Tim and his DiverseCS members spent three semesters during this collaboration preparing high school students to take the national advanced placement examination in computer science. Leaders of community organizations and schools often perceive DiverseCS's goals and their method of delivering outreach events as complementary to their own, engendering long-lasting partnerships.

Non-profit organizations also express a desire to work with DiverseCS leaders. These non-profit organizations typically have a mission that is consistent with DiverseCS, such as focusing on women in computing or increasing the representation of underrepresented racial and or ethnic minorities in computing. For example, Diane, speaking about partnering with the non-profit organization, Girls Inc., states:

> Girls Inc. reached out to us, probably, six or seven years ago to see if there were any students or faculty who will be interested in doing what are called lunch bunches, and it's just going into a cafeteria with a bunch of girls to talk about tech and we just started to talk about ... We have amazing technology in our building so we can help kids think broadly about tech and not coding and coding alone based on the incredible virtual reality spaces that we have, large touch screens, high definition interactive walls and things of that nature.

Diane's partnership with Girls Inc. began after a representative from Girls Inc. made an initial contact with Diane to complement Girls Inc.'s goals of providing educational opportunities to young women. In this manner, Diane has been able to leverage her technological resources, as an organizational leader, in the form of computer hardware and software to support Girls Inc.'s activities.

The beginning of an inter-organizational collaboration may be ambiguous, uncertain, and at times random. For example, Tim also describes how non-profit organizations contact him: "we get random emails, often forwarded to us. So someone reaches out to the engineering school and says I want to run a workshop on 'X'." Often community organizations contact a former member of DiverseCS, since organizational websites may not be up to date. Under such conditions, contact may be lost or become chaotic. Indeed, DiverseCS leaders often describe the initiation of a collaboration as "haphazard" or "informal." Serendipity also is the impetus for the beginning of many collaborations, as a DiverseCS leader may discover his child's elementary school teacher would like to teach their students computer programming. In this manner, interaction with collaboration partners and the initiation of collaborative arrangements are often random and laden with ambiguity.

Despite the ability of organizational members to use online search engines or other online resources in the digital field to locate potential collaboration partners, inter-organizational collaborations frequently form from a DiverseCS leaders' professional or personal relationships. For instance, Susan states:

> I email basically all the teachers that I know from all these high schools and teachers that I've gotten to know from the Computer Science Teachers Association meetings, there's mainly high school teachers, or K-8 teachers as well. I use the mailing list the Computer Science Teachers Association

Susan relies on her personal contacts that she has made through her professional role to begin a new collaboration. For Susan, online resources, such as a mailing list, provides critical contact information to facilitate collaborative activities, but those relationships often form from her existing contacts. Similarly, Jane describes the catalyst for collaboration as "it is mostly somebody who knows somebody that's how it works." By relying on people that they already know, DiverseCS leaders reduce the ambiguity of forming a new inter-organizational collaboration with a stranger. Moreover, and perhaps more importantly, DiverseCS leaders do not have many opportunities to foster the development of trust among collaboration partners since they usually also carry out their roles and duties as university professors. Relying on personal and professional contacts for collaboration serves as an efficient way to initiate a collaboration.

The network analysis of the digital field, demonstrates that academic conferences and meetings of professional associations are important sites for interaction and the exchange of ideas during proto-institutionalization. Echoing the quantitative findings, DiverseCS leaders describe conferences as opportunities to meet others that share an interest in diversity and computer science education. Such interactions sometimes coalesce into inter-organizational collaborations, through joint grant proposals or exchanging organizational personnel and knowledge. For instance, Susan's strategic use of the Computer Science Teacher's Association meetings exemplifies how conferences facilitate collaboration by providing a physical site for face-to-face interaction and networking opportunities. From this interaction, leaders may learn about opportunities to hold new outreach events or learn about new techniques to strengthen their emergent proto-institutions. In fact, one of the purposes of the annual DiverseCS meeting,

according to the senior leadership team, is to promote a learning community around sharing best practices of outreach activities.

Due to both the extensive personal and professional relationships among collaboration participants and that each participant shares a common goal of promoting diversity, conflict among collaboration partners seldom occurs. Major conflicts that result in the termination of an inter-organizational collaboration are rare, while minor conflicts do occur infrequently. Such minor conflicts arise from either student's neglect of the collaboration or miscommunication between the two collaboration partners. The student members, like the DiverseCS leaders, have multiple roles and responsibilities apart from DiverseCS, which contributes to the potential for students to neglect their responsibilities. For instance, Bobby states:

> We have done outreach programs and part of DiverseCS is we send undergraduate students into outreach situations, typically K-12 mostly to teach content or just engage students with CS concepts. We've had not do a great job, we've had students who didn't show up when they were supposed to or decide they didn't want to do something anymore and quit and didn't communicate to anybody.

Despite the challenges that the student members of DiverseCS may pose for the functioning of inter-organizational collaborations, leaders were quick to adapt and resolve any issues before they threatened the collaboration. Joe, a leader at a midwestern university, addresses the how the organization mitigates minor conflicts, "I mean, our students are flexible, and they ... I mean, I am just awed. My students just step up and step in and do what they need to do." From this perspective, building a flexible, resilient organization is a critical component to respond to and resolve minor conflicts. Both Bobby and Joe grant their student members autonomy to address minor conflicts during

interaction with collaboration partners and they empower them to take action, even when leaders do not control the sequence of events.

To mitigate conflicts, while instilling resiliency within their DiverseCS chapters, organizational leaders manage the expectations of their collaboration partners. When the expectations of all collaboration participants are in agreement, if there is a deviation from the procedure of an outreach event then each participant will have contingency plans in place to address actions that threaten the collaboration. In discussing a previous conflict where a student member neglected their responsibilities to a collaboration partner, Bobby states:

> I think everybody went in there with the understanding that that could happen, not that it wasn't a surprise but it wasn't a surprise that was so dramatic that the partner couldn't recover from it on their own. A lot of these partners that we worked with, particularly when it came to outreach, knew that they were working with somebody that was inherently unreliable.

When collaboration partners understand that the students that they work with are busy and may not be able to adhere to prior agreements, backup plans can address issues that may arise. For some leaders' backup plans include maintaining a reserve list of students for an outreach event in the case of a no-show. The ability to manage expectations is also crucial to the effectiveness of DiverseCS leadership. In this manner, Bobby discusses how, following the aforementioned incident, that he had to reevaluate the time commitment has asked of his students for outreach events. This type of flexibility in both expectations and among the commitments of DiverseCS members contributes to long-lasting community collaborations.

Perhaps more important than the resiliency among the students in a DiverseCS chapter is that each participant shares a common goal of promoting diversity.

Misunderstandings and minor conflict, while presenting some setbacks, rarely engenders the dissolution of a collaboration because both partners share a common goal, expressing passion and personal interest around advocating for diversity in computer science education. Leaders often emphasize that despite a bad experience with a student, the collaboration between their DiverseCS chapter and other organizations do not fail and continue year after year, due to all collaboration participants seeking to contribute to a common goal. For instance, Jane succinctly summarizes the importance of sharing a common goal: "who doesn't wanna help girls in technology right now." Jane's perspective, which is common among DiverseCS leaders, allows them to ignore or smooth over minor conflicts so that the activities of the organization can continue.

In addition to sharing a common goal, DiverseCS leaders often describe how better communication could improve the effectiveness of collaborations. There are two factors that increase the importance of communication for DiverseCS. First, while the goals of DiverseCS are relatively easy to understand, the tasks that the organization implements to meet those goals are not intuitive and ambiguous. After agreeing to become a DiverseCS leader, many people spend substantial time learning about the role and how collaboration occurs. Specifically, that the primary beneficiary of a collaboration agreement is the college student members of DiverseCS. DiverseCS is a service learning model. Moreover, there is no organization-wide template for accomplishing these goals. The top leadership team designed this specifically so that each DiverseCS chapter would be able to adapt to their local community. The second factor that contributes to ambiguity in collaborative arrangements is the uncertainty that a participant in the collaboration will not fulfill their responsibilities. The preceding

example where a student stopped working with the partner organization without prior notice exemplifies this type of uncertainty.

In addition to collaborations between DiverseCS leaders and local community organizations, there are few other types of inter-organizational relationships between DiverseCS and other organizations. Corporate sponsorships occur infrequently. Only a few DiverseCS chapters actively seek out and obtain sponsorships. Apart from sponsorships, the senior leadership team has begun to partner with other large non-profit and academic organizations to share the costs of their annual meeting. Intra-organizational relationships are prevalent in DiverseCS Regional groups of DiverseCS chapters frequently coordinate and communicate with each other to share best practices and to better coordinate outreach events. Additionally, the annual conference provides an important arena for intra-organizational relationships to form and be sustained throughout the duration of DiverseCS's existence.

Network enhancing strategies

The preceding discussion of collaboration in DiverseCS illustrates a variety of network strategies. To advocate for diversity practices, DiverseCS leaders build and cultivate their personal and professional relationships with a vast number of external and internal stakeholders. Whether forming a new collaboration or helping one of their student members attain an internship, the skillful use of one's personal or professional network represents a crucial strategy for success as a leader. Network enhancing strategies often require leaders spend a great deal of time getting to know other individuals and developing trust with them. Leaders that engage in proto-institutionalization rarely have spare time to devote to networking. Tim comments that

"If people had a wealth of extra time and energy I might encourage them to establish relationships with more than a single contact individual at an organization." Tim suggests that connections among collaborators is often tenuous, depending on ties between only a single representative from each organization.

Although DiverseCS leaders often lack the time to engage in networking, some leaders seek collaboration partners that complement their skills or can coordinate their work activity to pursue a joint goal. These leaders consider the competencies of potential partners and if there may be overlap in organizational goals they "aggressively seek or establish some relationship to participate in outreach." Indeed, Diane explains her motivation for pursuing a relationship with a leader of another non-profit organization:

> Women & Hi Tech is an organization in Indianapolis and it just makes sense that we're a technology program and we should have a relationship with them. With that relationship come invitations to participate in activities around the community to the point where you have to say, "If you do more things in the summer, I'm sorry, I just don't have the core to do it."

Building network ties with other leaders often provides opportunities for future outreach events and other inter-organizational collaborations. Additionally, as Diane suggests, strategic networking provides resources to the organization that can sustain organizational activities during proto-institutionalization, by ensuring that individuals continue to interact and experiment to innovate novel practices.

Although strategic network building is important, inter-organizational collaborations often happen as the result of serendipity. According to DiverseCS leaders, inter-organizational relationships occur due to the chance occurrence that a leader's professional needs and personal network aligns, as when their child's Girl Scout leader wishes to teach computer programming to her Girl Scout troop. From this perspective,

DiverseCS leaders respond to needs within their community, building inter-

organizational networks slowly, as opportunities arise from their local environment. For

example, discussing collaborations Joe states:

> I don't think we have anything formal. Just this past week, for instance, we got an email ... well, not me, but the computer science department faculty, several other people, got an email from a Girls Who Code chapter, a local Girls Who Code chapter, wanting to come to university to do a workshop for a day.

DiverseCS leaders often collaborate with other organizations, stemming from an

expressed need by organizations in their local communities that pursue goals germane to

computer science or diversity.

Moreover, the process of entering into collaborations changes over time. During

the early years of DiverseCS, organizational leaders would need engage in strategic

networking to conduct community outreach events. However, as DiverseCS leaders in

communities and at the national level hosted outreach events of various forms, the

organization become well-known within the field of computer science education.

DiverseCS's reputation shifted their method of initiating collaborations as Tim discusses:

> We actually have scaled back a little bit. But it is not uncommon for people to, somehow or another we have a reputation, I guess because we've been doing this for a while, and hopefully doing it well. So we get random emails, often forwarded to us. So someone
> reaches out to the engineering school and says I want to run a workshop on 'X.'

Strategic discourse

The context where proto-institutionalization occurs often becomes a confluence of

ideas, logics, and practices. Mobilizing the collective actions of organizational members

and collaboration partners under such conditions requires that leaders use discourse in a

manner that extends conversational bridges to others in the field. As DiverseCS leaders

must frequently interact and communicate with a diverse array of individuals, discursive

strategies provide leaders a lens to translate organizational goals into practice. Leaders use discursive strategies within DiverseCS to manage the ambiguity that besets both virtual interaction and the coordination of work activity. Organizational leaders note that ambiguity can cause substantial problems when coordinating with external stakeholders for an outreach event. DiverseCS leaders construct and share narratives to foster communication among their members and collaboration partners. In fact, storytelling, as a strategic component of leadership, has become institutionalized within DiverseCS. The process of constructing and sharing narratives influences efforts of institutional innovation within DiverseCS.

DiverseCS leaders often construct narratives that contain specific characters, settings, and plots to convey systems of meaning, invoke affective responses from others, and disseminate organizational practices. The characters of the narratives are often student members of DiverseCS or the children that partake in the outreach events. Narratives emphasize the heroic actions of a main character as they resolve a conflict or a tension relating to diversity. In many instances, a conflict occurs during an outreach event where a DiverseCS student member or an outreach recipient resolves an unexpected challenge. For example, a DiverseCS student member may need to make quick decisions and take on a greater leadership role to meet the shifting needs of an outreach partner, demonstrating that success in computer science requires that individuals are much more than the stereotypical "computer nerd." In other instances, a student may overcome adversity by resolving a technological challenge, demonstrating their computer science expertise. Regardless the specific challenge, narratives communicate how the practices of DiverseCS provide skills and advantages to young people.

Heroes and heroic acts permeate the stories within DiverseCS. For example,

Andy, a DiverseCS leader at a large university in the Southeastern United States recalls,

> We had a group of college students that were doing an outreach at one of our
> summer programs in Small Town, USA. And so at this particular session, a young
> African American woman, I think she was like in fifth grade, somewhere around
> there, fifth or sixth grade. So she had this idea about inventing a curling iron, a
> solar curling iron. And so all of her students in her age group had laughed at her.
> Right? But it was funny because all the adults in the back of the room were like,
> "Wow, that's a great idea."

Andy states that the young student further explained her invention,

> "Well, if you don't have any power and you don't have any batteries, or your
> battery's gone out, I need to be able to look cute when I'm out in the forest." And
> she just started talking about, "If you have a solar hot comb, then I can go ahead
> and curl my hair and not have to worry about electricity, or batteries."

The preceding narrative demonstrates how innovation occurs when individuals overcome

adversity. Importantly, DiverseCS provides the social context, through outreach events,

for such narratives to occur. As a leader, seeking to engender the emergence of novel

proto-institutions, Andy encourages other organizational members to share this narrative

to illustrate how divergent thinking, owing to diversity, can contribute to innovative

outcomes.

Leaders engage in storytelling to inspire DiverseCS members to take action even

when challenges may make action difficult. Specifically, Andy's narrative of the solar

powered curling iron strategically illustrates to his students how people's unique

experiences can become a source of innovation in computer science. Andy further

elaborates, "So the students started sharing that story, which then makes students more

comfortable to talk about their ideas so they can be innovating" Andy importantly

connects this narrative to DiverseCS' primary goals regarding diversity, thereby,

translating ambiguous goals into concrete organizational practices. Tim further elaborates

that through narratives "the dedication, and the passion, that our students have, I think it just really shows." He then shares the following narrative,

> We had two other students who started, on their own, the outreach to 5th and 6th grade classes in an elementary school. And they basically made it an afterschool club. And built the curriculum on what they did with these kids. And the school was so excited, they asked to continue it. And other elementary schools heard about it, and asked to expand the program into their school as well. So, the initiative, shown by these students has just had fantastic results.

As others learned of how Tim's student members created an afterschool club, they wanted to be a part of that initiative. Tim's narrative illustrates how stories may compel action within the organization. In this manner, the process of storytelling often mobilizes organizational members and collaboration partners to take action, especially when the narrative depicts organizational heroes.

DiverseCS leaders engage in storytelling for a variety of purposes. Many DiverseCS leaders choose to only share narratives internally – among their student members and other DiverseCS leaders. For instance, Andy's narrative provides brief illustration of the importance of diversity in regards to innovation; Andy usually only shares this narrative with his student members to spur action. The annual face-to-face meeting of the entire DiverseCS organization offers leaders and members an opportunity to exchange narratives. While these narratives portray organizational heroes, much like the preceding exemplars, face-to-face interaction allows the storyteller to ensure that their narratives resonate emotionally with their audience. For example, during a session at the annual meeting of DiverseCS, one student, James, spoke of his childhood in a developing Caribbean country, revealing that himself and others in the country rarely have access to running water and electricity, much less computers. James, a graduate student and a DiverseCS member, then tells how he now runs a non-profit organization that works with

some local schools of his home country to provide laptops and computer science education to supplement the national educational curriculum. James passionately described his narrative, serving as an emotional touchstone for many of the listeners.

The preceding narratives demonstrate that storytelling in DiverseCS fosters the emergence of a coherent organizational identity. Narratives that recount how student members or outreach recipients resolve challenges or tensions within their personal and professional lives connects each storyteller and audience member into a larger narrative of diversity, inclusion, and computing. In this manner, narratives instill a sense of community because they link the members of DiverseCS into a master narrative that transcends any single individual. This master narrative emphasizes how the actions of DiverseCS leaders and members impact the computing profession and student development by making computer science accessible to people. Bobby discusses this larger narrative of diversity,

> CS has long had this stigma that you have to be tape on the glasses, this pocket protector nerdy genius hacker… the stigma of what a computer scientist is, is exactly wrong in this generation of CS.

For Bobby and other DiverseCS leaders, this meta-narrative subsumes all other stories in the organization and maps directly onto the DiverseCS's primary goals. From this perspective, Tim emphasizes to his students how, as DiverseCS members, they belong to a national group that extends beyond the boundaries of their local communities. Specifically, Tim describes narratives as lending "credence to our program too, when we tell students that were one of more than 50 schools, and this is a national organization. That lends a lot of credence as well." Accordingly, individual narratives about a single outreach event or a particular student each contribute to this larger meta-narrative of

diversity within DiverseCS, mobilizing action within the organization and instilling a coherent identity.

In addition to promoting intra-organizational coherence through identity building, organizational leaders also use narratives to strengthen their relationships with their collaboration partners. Narratives allow organizational leaders to share DiverseCS's goals and practices in a manner that resonates with collaborators aligning goals and promoting confidence in the continuation of the inter-organizational collaboration. This use of narratives is important because the development trust is a crucial component for a successful inter-organizational relationship. Since DiverseCS leaders are computing professionals with job demands largely outside of DiverseCS, trust is often difficult to establish in a quick manner. When DiverseCS leaders collaborate outside of their personal networks, the establishment of trust becomes a central concern during the outset of a formation of a new collaboration. Addressing this issue, Diane describes the effects that sharing narratives about her particular students has on her relationships with the leaders of her non-profit collaboration partners:

> I think that they know that they can rely upon our students to do great things, they remember them by name from year to year. The folks at Girls Inc. will ask me how Rob and Tonya are doing, what's Bethany doing, I mean, they remember them by name. They can recall to me, and I don't remember, they can recall how somebody dealt with a certain kid. It's impactful, it's really impactful.

Diane's experience with her outreach partners illustrates how sharing narratives can rapidly build trust between strangers. By telling collaboration partners stories of previous successful outreach events or emotionally resonant moments, she is able to reduce the apprehension that her partners may have about coordinating work activity with DiverseCS.

Narratives not only strengthen inter-personal relationships between collaborators, but also between DiverseCS leaders and corporate sponsors or other organizations that offer resources to support the efforts of DiverseCS. Since outreach requires substantial resources in the form of technological resources and stipends for DiverseCs members, partnerships with organizations that provide resources are valued in DiverseCS. Narratives provide insight into how the activities of DiverseCS promotes diversity in computer science education. For example, Becca often tells her organization's corporate sponsors about the successes of her student members during their outreach events at local community organizations or schools. Her stories expound how DiverseCS exerts a positive impact on the local community. Regarding the narratives' effect on her relationship with corporate sponsors, Becca states, "The effect is you're more close to your corporate partner because now they want to come in, they want to see it themselves." Not only does sharing narratives foster trust, but it also promotes further interaction within the organization.

Finally, leaders share narratives through multiple forms of communication, from various information technologies to face-to-face interaction. Leaders frequently share narratives monthly through teleconference calls and newsletters. Nevertheless, communicating through many mediums poses difficulties. Technology issues have left some members without access to the organization's mailing list or other routine forms of virtual communication for months before there was a resolution to the issue. To address the difficulties of communication in a geographically dispersed organization, many DiverseCS leaders recognize the importance of integrating information technology with traditional methods of communication, such as face-to-face meetings. Such layered

communication, ensures that narratives disseminate throughout the organization. For

instance, Becca embraces multiple modes of communication,

> The best way to eliminate all these issues ever is to have the presentation using different media types. So, you have the information available on your website, you have it on your flyer, you have it, again, using your other social media tools, for example Twitter or Facebook if you're using it, and then they get it, they know what is expected.

Becca and other leaders leverage information technology and social media to create

multiple points of contact for members.

Moreover, the use of narratives as a mechanism for community building has been

institutionalized within the organization through the master narrative of diversity and

inclusion in computer science. For instance, as a component of each DiverseCS chapter's

annual performance evaluation, each leader must submit a narrative, describing the

preceding year's activity. Although, this form of narrative often takes on a different style

than those narratives told to members and collaboration partners, it does influence and

promote the construction of new narratives across the organization. For instance, Susan

asks her students to submit narratives shortly after the end of an outreach activity with

another organization. From the perspective of the top leadership team, narratives

illustrate each DiverseCS chapter's emerging practices to diversify computer science or

the organization's master narrative. As such, when shared, the narratives also foster

organizational learning, since leaders both reflect on their experiences to craft a narrative

and also have the opportunity to listen to others successes, and failures. Therefore, the

process of constructing and sharing narratives strengthens intra-organizational and inter-

organizational relationships and promotes the emergence of proto-institutions.

Forging a community

Since the majority of interaction within DiverseCS occurs virtually, organizational members at DiverseCS chapters may not identify with the larger organization. Moreover, when information technology fails to function, as when a leader's name unknowingly disappears from the email list, perceptions of belongingness to DiverseCS may sever. DiverseCS leaders took a variety of steps to overcome the inherent difficulties of communication and coordination across geographical, social, and digital boundaries. Two specific actions were to emphasize among all organizational members and collaboration partners a common goal of diversifying computer science education and to organize a multi-day annual meeting of the members of DiverseCS.

Organizational leaders and members orient their interactions within DiverseCS around a single goal of diversity. In this manner, the primary work activities of organizational leaders emphasize diversity and inclusion in computer science. For example, Becca states:

> When we have partnered with these universities or programs, I think in the orientations or first few meetings they were clear on the mission, that everybody who was there has the same mission, so nobody comes here with anything other than ... With one mission, and that is, "What can I do to recruit more students, retain them in the program, encourage them, keep them going?" Everybody is, they're eager to learn what system has worked in other universities and what they can do to adhere.

DiverseCS members often suggests that an overarching goal provides cohesion to them through their shared task. A common goal also reduces self-interested actions. From this perspective, conflicts that may occur during a collaboration are quickly resolved since both parties want to continue their joint pursuit of diversity. Accordingly, a common goal of diversity facilitates the formation of a coherent identity, as organizational members

make sense of their actions in light of their goal of diversity. The preceding section, discussing collaboration, further illustrates how a single goal contributes to organizational cohesion.

Second, recognizing the challenges when attempting to forge a coherent identity among autonomous organizational units, such as the DiverseCS chapters at each university, the senior leadership team openly sought to address how they could foster a community and identity, supporting DiverseCS's activities during the organizations founding. Taking action to instill a sense of community, the senior leadership team decided to host an annual meeting, where leaders and members from each DiverseCS chapter could interact in the same physical space once per year. The structure of the annual meeting resembles an academic or professional conference, where panels and speeches by the senior leaders and industry leaders in the field of computing occur at a time where every organizational member can attend. Additionally, meeting participants can choose to attend concurrent sessions that emphasize topics such as, outreach, diversity practices and student impact, and technology. As such, the annual meeting of DiverseCS offers a variety of opportunities for both formal and informal interaction.

Physical interaction provides a touchstone for organizational leaders and members that may communicate virtually or learn from each other's online resources, but usually do not speak face-to-face. At the annual meeting interaction constantly occurs among DiverseCS leaders, allowing leaders to contribute to the organization's functioning and its identity. For example, Jane describes the informal social interactions as, "hallway conversations and those breakout sessions where you're discussing those things are invaluable to the individual schools as well as making sure that the organization can

continue to move on." Accordingly, the annual meeting provides opportunities for people to meet and get to know one another. Indeed, the face-to-face interactions provide a rich social context to collaborate and communicate novel diversity practices, as Tyrone, a leader at a large southeastern university, states:

> The most productive conversations and collaborations I've had have been in person through the DiverseCS annual meeting. Those are nice because there are a few days where we can get away. That's what people are focused on right then. You don't have other things calling for attention in your office or whatever.

Through face-to-face interaction, DiverseCS members are able to learn about others experiences and organizational practices, promoting a community of learning. Many leaders arrive at the conference with issues or problems relating to the functioning of their chapter or concerns about the effectiveness of their community outreach practices. During the conference they are able to talk with others who share similar problems or have ideas on how to address their issues. For example, Jane states: When we realized that funding was my key issue we began to think about ways in which we could sustain DiverseCS. And of course going to the conference and hearing sessions about sustainability and people's ideas, that did also prompt us to rethink how we did it."

Interaction at the annual meeting fosters a sense of community, facilitating the emergence of a coherent organizational identity. Leaders and members of DiverseCS are able to take a step back at the annual meeting and understand their place among all of the other members. In this manner, they are able to make sense of how their actions contribute to the functioning of the organization, complementing the virtual interaction that occurs throughout the remainder of the year. Joe illustrates how the annual meeting fosters a sense of community by stating:

> Without the annual meeting, I would not have a sense or a feel for the organization, what it does, what it stands for, or anything, the ideology behind it. That's why I like to take my students to it, because it gives them a sense beyond what we do on our campus of what DiverseCS is, what it stands for, its mission. And I just think that's very important for them to get that bigger picture of where our student organization fits into the bigger picture of things.

The annual meeting engenders the type of meaningful interactions that form a community among organizational members. As such, organizational members report that after attending the annual meeting their members feel energized and engaged. Armed with new ideas from other organizations, their members are eager to experiment with new diversity practices.

The annual meeting also imparts the organization's goals to organizational members, especially those members who do not have a wide exposure to the activities of the entire organization. By sharing experiences and diversity practices, the annual meeting helps others better understand the high-level goals of DiverseCS. Organizational leaders also convey organizational goals by translating the ambiguous, high-level goals into concrete organizational practices. Nevertheless, the communication of shared goals underlies interaction within DiverseCS.

The digital field and radical change

Organizational leaders of DiverseCS often use social media to communicate with their colleagues at other chapters, their students, and their collaboration partners. By using social media, organizational leaders are able to maintain contact with DiverseCS stakeholders in an often uncertain and rapidly changing environment. Bobby emphasizes the importance of social media by stating, "I leaned heavily on social media, particularly Facebook. Facebook has allowed me to communicate quickly and easily with the students." Many DiverseCS leaders find similar value in other social media platforms,

such as Twitter, LinkedIn, and Instagram. Nevertheless, the degree of social media use and leaders' adoption of social media into the formal structure of their local chapter is not consistent across the entire organization. Among those leaders that do leverage social media for rapid communication, some find that social media engenders radical organizational change, such as the ability to connect to many more individuals with novel diversity practices than would otherwise be possible through face-to-face communication or other information technologies. Such interactions on social media further engender the emergence of proto-institutions.

Social media and the use of information technology to communicate among DiverseCS chapters has been prevalent since the organization's formation. During the early years of DiverseCS, the founding leaders sought to integrate information technology with the organization's formal structure in order to facilitate communication among the DiverseCS chapters across the southeastern United States. The leaders' primary goal was to use information technology to help forge a coherent sense of community among all DiverseCS participants. Their efforts were met with challenges, as many DiverseCS leaders did not actively use the communication platforms that were adopted by the leadership team. For example, Jane, discussing the senior leadership team's attempts to establish a communication platform states,

> I'm not normally going there and so I never really got into it in terms of using it and it didn't really seem like other people were using it. So there became no reason to go. So that was I think a time when that just really wasn't working very well and so that was difficult.

Besides the issue that many people simply did not use information technology to communicate with other organizational members, technical problems also hindered DiverseCS leaders and students from using communication software in the future. For

example, some leaders of the local chapters were unable to access the communication

platform and after repeated attempts to access the software gave up trying to do so.

Technical problems also occurred among the organization's email communications,

where leaders were unexplainably removed from receiving emails from the top leadership

team for several months to a year before recognizing that there was a problem. Such

technical problems, throughout the duration of DiverseCS's existence has led many

leaders to avoid reliance on information technology or social media.

In addition to the introduction of information technology to facilitate

organization-wide communication, the senior leadership team also encouraged the use of

social media. Much like the prior attempts to encourage the use of a common

communication technology platform, the implementation of an organization-wide

Facebook group or an active Twitter account did not occur. Tim explains why leaders did

not adopt this technology, "I don't think it's useful. I don't think anyone is particularly

invested in it." Other leaders describe social media as presenting them with an overload

of information, making it difficult to tease apart relevant information from trivial

information.

Although the senior leadership team did experience difficulties, in regards to

social media adoption, social media has made an impact on the dynamics of interaction in

DiverseCS. For the senior leadership team, a central concern of theirs since the

organization's founding was how to instill and sustain a sense of community and a

coherent identity. To address this concern, they implemented social media as a

community building device at DiverseCS's annual meeting. Student members at the

meeting were encouraged to use hashtags to share content and photographs pertaining to

their experiences. Becca, a DiverseCS leader at a large Southern university, recalls

> We were at one of their conferences and they were using Twitter to maintain a wall of students posting tweets. That was fascinating to see how all liked tweets were helping students to get connected

Becca describes how social media use, as a bottom-up process, facilitates the emergence

of a collective identity among the student members. The aggregate sum of the social

media posts, connecting experiences and images together, forms an organizational

narrative, celebrating the organization's prior successes and their members. From this

perspective, individual social media posts facilitated the emergence of an organizational

narrative that transcended the contributions of any single member. Additionally, by

posting their experiences on a social media platform that identifies the connections

among users, the students were able to extend their own personal and professional

networks. Taken together, as an intra-organizational tool, social media, with minimal

effort from any single individual leader or member, may contribute to the larger

organizational goals of providing a sense of community to the organization's members.

Although organization-wide adoption of social media did not occur, several

DiverseCS chapters independently use social media. Indeed, DiverseCS leaders

frequently recognize one of their colleagues, Ben, a DiverseCS leader at a large

Southeastern university, for his skill and extensive use of social media, through Facebook

and Twitter. Moreover, during outreach collaborations, some community leaders use

social media as their primary communication tool with their DiverseCS partner.

However, within DiverseCS, social media use most often occurs when a DiverseCS

leader uses social media as a tool to communicate with and interact with their students.

For these leaders, social media has become an indispensable tool that facilitates ongoing

communication and the potential for positive, radical change within their organizations.

      Several DiverseCS leaders leverage social media in their chapters to sustain

continuous, adaptive organizational change. These leaders rely on social media to interact

with their student members outside of regular face-to-face meetings. Importantly, social

media provides a means to interact dynamically, allowing leaders and students to rapidly

respond to each other. Social media also compels others to interact, as a post often

necessitates a further comment. This type of interaction facilitates emergent phenomenon.

While there are various social media platforms that DiverseCS leaders use to

communicate with their students, they often use Facebook. For example, Bobby

comments,

> I heavily rely on Facebook groups. It's low cost for me to put something into
> Facebook and its high reach to my students and my alumni collaborators. I built a
> Facebook group just for our students and that's where I push all my content to
> them.

Through Facebook leaders interact with their members without investing substantial

resources. After learning how to use social media, organizational leaders are able to

communicate with more people than would be possible with other information

technologies. Moreover, social media allows leaders to monitor who receives their

communication, enabling them to better plan work tasks. Bobby further discusses how

social media helps him,

> The nice thing about Facebook groups is they let me see how far they do reach so
> I can see that 60 people say this, if 60 people saw this then at least one of them is
> probably going to do it and that's a win for me.

Bobby demonstrates how virtual interaction translates into tangible outcomes for

DiverseCS leaders that choose to use social media technology.

While DiverseCS leaders use social media to substantially expand their capacity to communicate with organizational members, social media can also exert a transformational effect on interactions within the organization. Among the leaders that embrace social media as a primary tool of communication, some leaders have found that social media provides a social context that empowers their student members to take on additional roles and tasks. Through virtual interaction, posts on social media may coalesce into new outreach events or opportunities for collaboration, as more student members express interest and contribute to the emergent organizational action. Bobby describes how this process unfolds,

> A number of our students now have been finding things and posting them to the Facebook group as well so it's not just me now from my ivory tower throwing information down to students now. Now it's the students collaborating amongst themselves to find opportunities and build opportunities from the selves.

Bobby's explanation emphasizes the importance of leadership when leveraging social media for radical organizational change. More specifically, leaders enable change by increasing the opportunities for interaction available to their members and by simultaneously granting them autonomy to take action within the organization. Leaders cannot force radical change to occur, however their actions may make it more likely. For instance, Bobby's student members use social media to engage in dialogue with each other about diversity practices and opportunities to conduct outreach events advocating the value of computer science. They use the features of social media to plan events and tag each other in posts. From these interactions, Bobby describes on how his student's use of social media results in opportunities to increase cohesion among his students.

> A couple of our students have really taken it all on themselves to get other students with them going to hack-a-thon's, so we've gone to hack-a-thon in

Raleigh, North Carolina, Lexington, and Louisville, and at all three of them they won first prize at and some groups have one second and third prize...

Taken together, social media affords opportunities for bottom-up interaction that may result in emergent processes, such as the formation of new diversity practices or opportunities to experiment with new proto-institutions. From this perspective, leaders that enable frequent interaction among their members and empower those members to take action foster such change processes.

Negative case analysis

Negative case analysis requires the researcher to seek data that disconfirms emergent categories (Tracy, 2013). Accordingly, negative case analysis contributes to the credibility and transparency of the qualitative analysis by ensuring that data are not cherry picked to support an a priori model. Although DiverseCS leaders often emphasize their commitment of advocating for diversity practices in computer science education, several leaders pursue their own personal and professional goals. Moreover, while a common goal of diversity reduces inter-organizational conflict and inhibits competition, some leaders perceive themselves to be in competition with other non-profit organizations at times. Together, each negative case provides a more complete illustration of action within digital fields.

DiverseCS leaders often use their leadership positions to fulfill their personal or professional obligations. For example, leaders may use an outreach event to enrich their children's educational opportunities or their accomplishments in DiverseCS to gain career advancement. Tim further elaborates:

You know, I guess I should also add that being the DiverseCS leader, and the fact that there is a national organization is actually good for me career-wise as well. Because, it shows service, and outreach, and all of those things. And up for promotion this year, and the promotion committee highlighted that fact. That we

are one chapter of this large national organization. And so, there's a tangible benefit for being a faculty advisor, career-wise as well.

Tim's experiences demonstrate how DiverseCS leaders seek out synergies in their work as a leader and their other professional roles. Indeed, the founding team of DiverseCS sought to allow enough flexibility in the organization's goals so that leaders could both pursue goals of diversity and other professional goals. Nevertheless, one DiverseCS leader enlists their student members to serve as research assistants for them. In this DiverseCS chapter there are no outreach events with schools or community organizations. From this perspective, some interaction within DiverseCS occurs through transactional exchange, where each individual negotiates the allocation of rewards during interaction.

Additionally, some DiverseCS leaders compete with other DiverseCS leaders to gain desirable outreach experiences. For example, Joe states:

> One year, when I was actually teaching a class to offer course credit for DiverseCS activities, I did email the leader at Midwest Tech, and I asked him if there were projects that he felt that my students could help with. And I guess he's on a contact list somewhere in the area, because he had a whole list of people who had contacted him for assistance with afterschool programs and things. I mean, he had a really long list, but he said, "But I'm only going to give you what my students won't do." And that's exactly what happened. He didn't really give us the list until very late in the semester, till he knew his students had fulfilled what they wanted to do on the list, and then by that time a lot of the things were over.

Joe's statement illustrates how, despite sharing a common goal, competition occurs among organizational leaders during proto-institutionalization. Competition also occurs between other organizations, especially over student members. There are many organizations that seek to recruit student members. Tim explains;

> We have an ACM chapter. We have a WICS chapter, Women in Computer Science chapter. We have a Epsilon Pi Epsilon chapter, and then there's some

separate ones devoted to specific technologies. Like a Unix/Onyx group, and a game group. So, there's a lot of groups competing for membership.

The negative case analysis demonstrates that, although DiverseCS leaders emphasize positive relationships between themselves and other organizations or other organizational leaders, competition among organizations does occur. Organizational leaders do, in fact, strategically seek to gain positional advantages vis-à-vis other organizations in the organizational and digital fields. In conclusion, the preceding analysis and exemplars complement the primary qualitative findings that suggest a large degree of collaboration occurs among organizational leaders by illustrating that competitive forces shape, at least some, interactions during proto-institutionalization.

CHAPTER 6: DISCUSSION

The digital field

This study introduces the digital field as a novel theoretical construct that exerts substantial influence over the actions of an organization's members. The digital field is a socio-technical structure, consisting of websites and the hyperlinks between websites. Websites include those that primarily contain content on a particular issue such as, organizational websites, conferences, social media accounts, blogs, news organizations, and professional associations. As such, the digital field affords individual and organizational actors with opportunities for interaction. Of particular importance, the digital field affords actors with frequent, independent interactions, which uniquely structures virtual interaction.

Giddens' concept of the 'duality of structure' provides insight into the processes that produce the digital field (Giddens, 1984), where the actions of organizational leaders and members contribute to the creation of websites and hyperlinks – the digital field – and, in turn, the content and arrangement of information in the digital field exerts influence over the actions of organizational leaders and members. This recursive relationship between social action and technology structures the digital field (DeSanctis & Poole, 1994). Therefore, from a macro-analytical perspective, the digital field adheres to the process of adaptive structuration (DeSanctis & Poole, 1994), as the macrolevel properties of the digital field offer affordances for action to individual and organizational actors (see Gal et al., 2014).

The digital field exerts substantial influence in how actors engage with others over a pertinent organizational or societal issue. That the colloquial term for searching for

information is to *google*, exemplifies the influence of the digital field over everyday

interactions. Moreover, a website's ranking on Google affects how actors access the

information on that website, which then influences the action of those actors. Examples

such as these demonstrate how actors use technology and interact in a digital context. In

fact, actors often search for information through search engines when choosing

collaboration partners, coordinating organizational efforts, and implementing

organizational practices. Search engines constrain all relevant information about a query

into only several hyperlinks per page of results out of potentially thousands of hyperlinks.

Actors are unlikely to find information that is more than a few pages from the first page

of results. From this perspective, search engines exert a convergent pressure on actors

within the digital field, as actors that submit similar queries will only view similar results.

Daniels (2018) illustrates how actors may strategically manipulate search engine results

to gain advantages vis-à-vis other online actors. In this manner, search engines, as a

single form of technology in the digital field, enable both convergent and divergent

organizational action.

Individual and organizational actors often seek to resolve shared issues through

virtual interaction (Ince et al., 2017; Milan, 2015; Powell et al., 2016). Whereas search

engines demonstrate how actors interact with technology, social media illustrates how

information technology facilitates social interaction. Social media and webpages provide

the means for actors to meaningfully engage others (Leonardi and Vaast, 2017). For

example, following George Zimmerman's acquittal of Trayvon Martin's death on July,

13, 2013, the hashtag #BlackLivesMatter spread across social networking sites, Facebook

and Twitter. Actors were able to use hashtags to reframe the identity of the movement by

combining emerging systems of meaning together in a manner that resonated among audiences bringing the issue of racial inequality to the forefront in American public discourse (Ince, 2017). Occupy Wall Street and Arab Spring revolutions also have their origins in social media. In this light, social media allows individuals to enter into a field and interact with an issue, whether through opposition, support, or indifference. Therefore, actors use information technology in a variety of ways; they use online search engines to locate information, they browse websites, create hyperlinks to direct others to useful information, and use social media to communicate and coordinate their work activity. The introduction of the digital field, as a novel theoretical construct provides a means to integrate virtual activity with institutional theory.

Collaboration in the digital field

Prior studies of proto-institutionalization tout the importance of collaborative relationships among organizations (Lawrence et al., 2002; Powell et al., 2016). Collaboration facilitates the creation of novel institutional practices by providing a context to combine complementary knowledge, skills and resources that any given actor does not possess unilaterally (Dougherty & Dunne, 2011). Nevertheless, collaboration does not occur in a social or technological vacuum. The digital field structures the dynamics of collaboration and affects the observable traces of the collaborative arrangement. Virtual interaction and physical interaction intermingle. For example, an actor may use social media to coordinate with a collaboration partner, building trust and fostering a sense of familiarity through social media messages; this virtual interaction dramatically alters the face-to-face interaction when they work together to accomplish a joint task during a physical collaborative meeting. From this perspective, the leaders of

DiverseCS often put information on their organizational websites to enhance the functioning of an inter-organizational collaboration. Thus, organizational information on a website, such as organizational narratives and knowledge germane to organizational routines, aids collaboration partners' development of swift trust in an uncertain environment. From this perspective, virtual and the physical activity each contribute to successful organizational outcomes.

At the confluence of virtual interaction and proto-institutionalization, mutual hyperlinks are often taken to represent a collaborative arrangement between two organizations, as a dyadic hyperlink requires mutual recognition of a relationship by at least one actor from each organization (Ackland, 2013; Powell et al., 2016). The results of this study indicate that hyperlinks often do not reflect inter-organizational collaborations. Among the 4158 websites of the digital field of diversity issues in computer science education there were only 85 mutual hyperlinks. Taken as an indicator of collaboration, the 85 mutual hyperlinks suggest a low degree of collaboration, which is not supported by the qualitative analyses. In contrast, leaders of DiverseCS create hyperlinks for a variety of reasons. Hyperlinks may represent collaboration, but they also may indicate that one organization provides deference to another organization as a show of status. Moreover, hyperlinks are often outdated, as curation of online content is time consuming (Ackland, 2013), especially for professionals whose primary job is not to advocate for diversity practices. The results of this study are consistent with Thelwall's (2006) conclusion that there is no universal theory for hyperlinking. Importantly, I contend that investigations of the digital field benefits from qualitative data as there are a variety of ways individuals may use technology and construct meaning through that use.

Rather than information technology spurring inter-organizational collaborations, organizational actors enter into such collaborative arrangements through both physical and virtual interaction. Collaborations arise from a joint need by two or more organizational actors to coordinate their work activity (Doz, 1996). DiverseCS leaders often use their personal and professional networks to locate collaboration partners. For example, several leaders collaborate with schools where their children are students. In addition to these close ties, potential collaboration partners also contact DiverseCS leaders with specific needs. These potential partners are often leaders of non-profit organizations, governmental associations, or local educators and discover information about DiverseCS from online searches or from their personal relationships. In this manner, while collaborations often form as the result of face-to-face interaction, information in the digital field facilitates collaboration relationships through enabling information search (Rangan, 2000). Aiding in the effectiveness of partner search is important, as the search process is costly and contributes to successful collaboration outcomes (Rangan, 2000; Reurer, & Deverakonda, 2017). Organizational leaders, therefore, use information on the digital field to match collaboration partners.

Exploring inter-organizational collaboration demonstrates how physical and virtual interaction exert tensions that facilitate efforts of proto-institutionalization. Tensions introduce movement into organizational systems by pushing actors towards either equilibrium or edge of chaos states and are ubiquitous in complex organizational systems (Solansky et al., 2014). Prior research documents how tensions resulting from information technology use may move an organizational system out of equilibrium and towards the adaptive regions of complexity, at the edge of chaos (Beck et al., 2018).

Virtual interaction tends to exert a destabilizing tension on organizations whose members are dispersed geographically, while physical interaction punctuates the equilibrium of virtual interaction, interjecting energy into the organizational system. Accordingly, incorporating tensions into the theoretical framework of proto-institutionalization provides a mechanism through which individual action influences organizational and field-level structures.

The digital field and information technology use, in particular, ostensibly affects the dynamics of inter-organizational collaborations through information technology affordances (Gal et al., 2014). Indeed, the development of information technology tools has greatly transformed collaborative forms of organizing (Beck et al., 2018; Zammuto et al., 2007). As previously noted, information technology has greatly reduced transaction costs within interorganizational contexts by lowering structural barriers to information and ensuring that information is accessible to each participant. Indeed, information technology "has become an integral feature of organizational life" (Gal et al., 2014: 1372). Nevertheless, the use of information technology may contribute to conflict, as each participant in an inter-organizational collaboration may use differing technologies. In DiverseCS conflict often occurs when technology becomes outdated or no longer functions properly. Organizational leaders that are removed from mailing lists or are no longer notified of monthly teleconference calls express disappointment with the organization, decreasing their commitment. In this manner, conflict arises from the properties of the technology, unrelated to human error. Moreover, conflict with technology precludes organizational learning, as leaders who lose contact with the

organization due to a technical error continue to work, but do not communicate successes, failures, or quandaries to other organizational members.

Conflict may also occur when organizational members select technology to use to support intra-organizational or inter-organizational collaborations. Organizational leaders often encounter resistance from others regarding information technology adoption (Brown et al., 2010). Resistance to information technology not only wastes organizational resources (Brown et al., 2010), it also inhibits the emergence of organizational identity (Gal et al., 2014). During the founding years of DiverseCS, senior leaders often thought, "if we are unable to communicate, then who are we?" Organizations that incorporate information technology into their technical core, rarely meet face-to-face, therefore, the establishment of an organization-wide technology platform is necessary for the functioning of the organization and for organizational members to collaborate with others in the digital field.

By considering conflict arising from actors' use of technology, the concept of the digital field extends Martin's (2003) field theory. Prior conceptualizations of field theory remain agnostic to the interaction that occurs between actors and technology. As such, the digital field mediates interaction. When actors interact with technology they enact social structures that influence proto-institutionalization, such as organizational narratives on websites and social media posts. Moreover, information technology may destabilize interaction (Beck et al., 2018), engendering radical change within the field Accordingly, field theory should not myopically explore the person and the environment in isolation, but also focus on technology. The use of technology alters the forces present within the

field. Although emergence is possible in any field, interaction in the digital field makes

emergence a much more likely possibility.

Emergence in the digital field

The digital field affords organizational leaders and members opportunities for

complex interaction, resulting in emergent outcomes like proto-institutions. Virtual

interaction with technology and other actors increases the degree of complexity among

intra-organizational and inter-organizational relationships (Beck et al., 2018).

Specifically, complexity within organizational systems increases due to both frequent

interaction among individuals and by the interdependence that information technology

necessitates among individuals. Organizational leaders and members that engage in

virtual interaction, whether through online search engines or through collaboration with

others, position themselves into a structural arrangement in the digital field, relative to

other field members. Frequent, inter- interaction serves as a force of momentum within

the organization, enabling emergent outcomes (Beck & Plowman, 2014; Miller & Page,

2007). From this perspective, information technology alters how individual action

produces emergent phenomenon.

Although all information technology may introduce complexity into

organizational systems (Beck et al., 2018), within DiverseCS, social media often

becomes the catalyst for emergent organizational change and institutional innovation.

Social media refers to information technology that allows users to generate content in an

interactive manner with other users (Aichner & Jacob, 2015). Additionally, social media

enables asynchronous communication, permitting interactants to communicate frequently

and as their schedules permit. Accordingly, social media facilitates communication and

coordination over temporal, organizational, and geographic boundaries (Leonardi and Vaast, 2017). By serving as a boundary crossing tool, social media allows actors to interact with divergent systems of meaning, exposing contradictions and highlighting complementary logics. In this manner, social media use engenders complex interactions. Figure 14 depicts how information technology facilitates the emergence of proto-institutions. Specifically, this diagram illustrates emergence with social media interaction.

Emergence often occurs when an organizational system moves beyond the boundaries of an equilibrium state, towards the edge of chaos (Solansky et al., 2014). More than a metaphor, the edge of chaos is a region of interaction where stable social structures cannot emerge due to excess uncertainty and rapid interaction (Eisenhardt & Brown, 1998). In contrast, interaction in an equilibrium state constrains organizational action into bureaucratic rules, precluding the possibility of emergence. The region of complexity, where non-linear, radical changes are possible, lies between equilibrium and chaos (Solansky et el., 2014; Maguire & McKelvey, 1999). Organizational systems may remain in the region of complexity due to the forces of stabilizing and destabilizing tensions (Beck et al., 2018; Solansky et al., 2014). In this manner, interaction through social media often moves to a far from equilibrium state (Beck et al., 2018). Nevertheless, absent tensions, interaction would quickly fall back to equilibrium or cross over into chaos. For example, without access to diverse institutional logics or systems of meaning to push action towards the edge of chaos, interaction among actors pursuing proto-institutionalization would become inflexible. In this manner, interaction that holds the capacity for emergence subsides into organizational routines. In contrast, the pursuit of various goals by actors results in chaotic interactions that preclude the possibility of

self-organization, as actors pursue individual goals without regard to a collective effort of proto-institutionalization.

The theoretical construct of tensions facilitates the development of a theory of proto-institutionalization in a digital context. Solansky and colleagues (2014) propose that two types of tensions, in combination, steady an organizational system into the region of complexity. Destabilizing tensions move a system towards chaos where actors are loosely coupled and pursue divergent goals. Destabilizing tensions amplify system-wide deviations through feedback loops, promoting chaotic interactions where action is unpredictable and precludes the formation of stable social structures. In contrast, stabilizing tensions move a system towards equilibrium, where actors are tightly coupled and pursue convergent goals. Stabilizing tensions dampen system-wide deviations through positive feedback loops. The use of information technology, such as social media, introduces each of these tensions into the organizational system (Beck et al., 2018). While Beck and colleagues (2018) focus on how information technology can spur to formation of novel organizational structures during inter-organizational collaborations, I contend that information technology introduces destabilizing and stabilizing tensions that promote the emergence of proto-institutions. DiverseCS leaders frequently emphasize the importance of cohesive organizational processes, such as goal alignment and identity formation, while also encouraging interaction among their organizational members with other disparate organizational actors. Figure 14 illustrates how social media introduces tensions that move interaction into the region of complexity. Figure 14 highlights the specific characteristics of each tension type.

Several destabilizing tensions move interaction on social media towards the edge of chaos. First, the digital field imports information into the organizational system. As information technologies facilitate communication, numerous and diverse information flows into an organizational system. An increase of information often catalyzes emergence in complex systems (Kauffman, 1995; Miller & Page, 2007). In the context of proto-institutionalization, information may consist of knowledge about organizational practices and routines, blueprints for proto-institutions, knowledge about organizational status, and the structural positions of field members. Actors use information to increase the diversity of individual activity through experimentation (Miller & Page, 2007) and learning by doing. In this manner, information allows actors to integrate and synthesize new systems of meaning and experiment with these practices. Accordingly, information accessibility may increase the frequency of interaction. As actors learn about novel systems of meaning and practices they are more likely to implement those practices. For instance, in DiverseCS organizational members use Facebook and Twitter to coordinate outreach events and promote organizational learning. The structure of the digital field also influences how information affects proto-institutionalization. Digital fields that possess a complex network structure, particularly those that may be characterized by a small average path length, ensure that actors have access to information. The network analysis of diversity issues in computer science education demonstrates that individuals that seek to innovate diversity practices have multiple online repositories to learn about emergent practices and relatively few barriers to impede access.

Social media also increases interdependent interaction further moving an organizational system to the edge of chaos. Posts on social media often compel others to

respond. Interaction on social media links users into a relational web of communication.

DiverseCS leaders that use Facebook to encourage interaction among their student

members often realize the occurrence of more outreach events and the development of

new forms of outreach. Although many factors foster emergence through the use of

information technology (Beck et al., 2018), within DiverseCS autonomy catalyzes

bottom-up interactions on social media. To leverage social media for emergence, leaders

grant autonomy for their members to interact freely online and encourage such

interactions. They place information on a shared social media page so that other members

my respond, synthesizing or creating new meanings regarding diversity and

organizational action. Leaders also must promote the transference of online activity to

physical activity. Proto-institutions cannot exist entirely in a virtual form, but rather must

be enacted through face-to-face interaction in the physical world. Therefore, leaders that

encourage the emergence of novel proto-institutions guide the interaction of

organizational members, from virtual to physical interaction.

Third, social media increases the frequency of interaction among organizational

actors. For example, posting a message to another user requires little effort; moreover,

more than one person may be able to view public posts. In this manner, potentially

millions of individuals may view a single post and have the ability to interact with that

post (Ince et al., 2017). As some DiverseCS chapters replaced their face-to-face meetings

with a shared social media group, members began to communicate with each other more

frequently. If a leader or member finds an interesting online article about diversity, they

may provide a hyperlink to that article on the group's social media page, compelling

further interaction as other members view and discuss the article. While face-to-face

interaction is circumscribed by the limitations of time and space, virtual interaction encounters no such constraints. In this light, social media use introduces destabilizing tensions as both the number of interactants increases and the frequency with which they interact increases.

Finally, social media introduces diverse institutional logics that destabilize interactions, making possible novel interactional patterns (see Seo & Creed, 2002). The digital field contain paths to information that reflects distinct communities each with separate understandings and practices regarding issues. As hyperlinks communities and virtual spaces reflect various institutional logics and systems of meaning (Powell et al., 2014), the complexity of the digital field increases the likelihood that emergence will occur through social media interaction. For example, a digital field with a small average path length permits individuals to easily cross digital boundaries, combining ideas and exposing institutional contradictions. Additionally, several websites in the digital field that have a particularly high degree distribution will pull social media activity towards themselves, serving as basins for virtual action (Kauffman, 1995). Such websites become tags for action in the digital field, ensuring that action contributes to the formation of novel proto-institutions). In this manner, the structural properties of the digital field destabilizes interaction by introducing new systems of meaning and making novel interactional patterns possible.

While destabilizing tensions move interaction on social media towards the edge of chaos, stabilizing tensions push the system back towards equilibrium. Their combination ensuring that interaction remains in the region of complexity where adaptive

organizational change is possible. I will now discuss the two dominant stabilizing tensions: a coherent organizational identity and the recognition of a common goal.

The formation of a coherent organizational identity exerts a stabilizing tension into virtual organizational systems. Within DiverseCS, social media use contributes to the formation of a collective identity among leaders and members. Social media use alters interaction by orienting organizational members to common goals and actions (Gal et al., 2014). As individuals use information technology, interaction often becomes less individualistic and more relational and collectivist (Gal et al., 2014). When DiverseCS leaders use social media at annual meetings as a method of documenting narratives and experiences of members, interaction among those who use social media in the organization becomes more relational. In this manner, social media such as Facebook or Twitter, displays the connections between users or social media posts. Posting content on social media reduces barriers, affording organizational members opportunities to view their position within the organization in relation to their colleagues. Organizational members view themselves as being a part of something "bigger than themselves." Additionally, social media allows organizational members the ability to share narratives that promote positive associations with the organization and demonstrate the utility of the organization's actions in the context of proto-institutionalization. These narratives capture the "central, enduring, and distinctive" qualities of the organization, allowing members to translate narratives into constructions of organizational identity.

A coherent organizational identity also serves as a *tag*, orienting the actions of organizational members (Marion & Uhl-Bien, 2001). In complex systems, "tags enable specific behaviors by directing attention to what is important, and what things mean"

(Plowman et al., 2007b: 352). Organizational members may find membership in dispersed organizational contexts confusing due to frequent shifts in both interactional patterns in organization and the environment (Gulati et al., 2012). For example, meta-organization teams experience competing tensions that moves action away from equilibrium, towards the edge of chaos (Solansky et al., 2014). When a social system moves away from equilibrium, tags provide a stabilizing force, preventing the system from drifting into the region of chaos. Organizational identity stabilizes the organizational system by ensuring that interaction relates to the organization's goals and the issues of the field. For example, DiverseCS leaders sought to instill a sense of community and identity into the organization during its inaugural year so that organizational members would work towards several common interrelated goals, rather than pursue their own idiosyncratic interests. When members pursue their own interests work activity towards the goal of diversity in computer science education decreases, as shown in the negative case analysis. In this manner, during proto-institutionalization, an organization's identity becomes a tag when the identity adheres to the social codes of the field. The identity, therefore, catalyzes action within the organization towards organizational goals without exerting an overly dampening effect on action.

Finally, a common goal among organizational members exerts a stabilizing tension on virtual interaction. A central concern of those in the digital field is addressing the issue which prompts field formation; this common goal curbs divergent action resulting from destabilizing tensions. Solansky and colleagues (2014) refer to this type of common goal as a compelling direction. According to DiverseCS leaders the goal of diversifying computer science education often allows collaboration partners to ignore

minor conflicts or miscommunications, enabling them to continue to focus on their joint efforts. Moreover, interaction with other DiverseCS members at the annual meeting of the organization energizes their actions. In this manner, the common goal of addressing diversity issues encourages actors to coordinate their activities.

Interestingly, while members of DiverseCS share a common goal, many members use their positions within the organization to pursue their own idiosyncratic personal or professional goals. For instance, one DiverseCS member organizes their local chapter as a research laboratory, employing student members to conduct routine tasks. Indeed, the senior leadership team sought to provide DiverseCS leaders opportunities to further their own careers as a component of their roles. Nevertheless, due to the low number of participants that discussed the pursuit of goals that are not consistent with the primary goals of DiverseCS, the extent to which individual goals motivate action beyond the common goal of diversity remains ambiguous. Specifically, the data is unable to determine whether the pursuit of individual goas in this context is prevalent enough to serve as a destabilizing tension.

Together, each of these tensions moves interaction on social media or other arenas of the digital field into the region of complexity. Emergence occurs through both the organizational dynamics within the digital field and the technical properties of the field. The technical features of the field enable emergence through facilitating numerous and frequent interaction. The hyperlinks within the digital field break down barriers that separates institutional logics, allowing actors to realize the contradictions that motivate radical institutional change. Accordingly, network complexity ensures that actors are able to access information and support their physical enactments of nascent institutional

practices. Finally, feedback loops occur as individuals post these face-to-face experiences on social media and in the digital field, thereby re-starting the process depicted in Figure 14. Emergence does not only occur through the properties of the digital field, organizational leaders contribute to emergence through several actions, as discussed below.

Leadership and the micro-foundations of the digital field

Organizational leaders use three socio-technical actions to enable proto-institutionalization in the digital field. Table 5 details each of these actions. First, leaders seek to forge a coherent identity among organizational members and, through information and communication technology, convey that identity to others in the field. Second, leaders strategically unite people and coalitions who may provide resources for their proto-institutionalization efforts. Finally, leaders employ narratives as a primary discursive strategy to and communicate organizational goals and facilitate a shared understanding a rapidly changing environment that often characterizes proto-institutionalization (Powell et al., 2014). Each of these skills are crucial to proto-institutionalization efforts. Moreover, the digital field structures these skills in a manner that does not directly correspond to action in the physical world.

Before turning to the actions of organizational leaders during proto-institutionalization, I briefly discuss how my findings of leadership actions complement and also diverge from to traditional theories of leadership, such as charismatic leadership (Waldman & Yammarino, 1999) or transformation leadership (Bass, 1985). Specifically, leaders that demonstrate charisma inspire their followers to exceed expectations and organizational goals that emanate from deeply held values (Waldman & Yammarino,

1999). In this manner, organizational members hold a great amount of esteem and respect for the leader, motivating them to act in accordance to organizational goals. Similarly, transformational leaders are often highly charismatic and leverage their personal qualities to engender personal and professional development among their members (Avolio et al., 2009; Bass, 1985). Transformational leaders highlight connections between their follower's identities and social or organizational issues to help them attain higher levels of self-actualization (Bass, 1985). Accordingly, both charismatic and transformational approaches to leadership explain follower action as the result of the aspirational actions of leaders.

To be sure there are several points of overlap between my findings and the central propositions of charismatic and transformational leadership theories. For example, DiverseCS leaders strive to cultivate a coherent organizational identity to ensure that member actions address a shared goal. Identity building is a major component of transformational leadership (Bass, 1985). Nevertheless, the foremost departure from traditional theories of leadership and my findings is the emphasis on frequent, decentralized interaction by DiverseCS leaders. DiverseCS leaders empower their members to coordinate, communicate, and experiment with emergent proto-institutions by working with numerous other actors. Traditional leadership theories remain agnostic to such interactional processes (Marion & Uhl-Bien, 2001). Therefore, charismatic and transformational leadership do explain some of the actions of DiverseCS leaders. Nevertheless, the context of proto-institutionalization in a digital context suggests non-traditional forms of leadership can usefully explain leadership actions. Owing to these considerations, I draw heavily on complexity leadership and institutional leadership

theory to offer a theory of leadership during proto-institutionalization. I now elaborate upon each of these strategies of action and their requisite skills below and offer several theoretical propositions for each.

Organizational identity

A variety of organizational forms reside within the digital field. Many organizations, such as conference associations, some non-profit organizations, and industrial associations may be thought of as meta-organizations (Gulati et al., 2012; Solanksy et al., 2014). Meta-organizations consist of "organizations or individuals not bound by contractual employment within a single organization, but characterized by an over-arching goal" (Solansky et al., 2014: 1009-1010). DiverseCS exists as a meta-organization where computing professionals may engage in goals to increase diversity within computer science education, while maintaining employment with a university. Therefore, meta-organizations allow individuals to innovate proto-institutions about issues with which they may personally identify, while maintaining other employment arrangements. Nevertheless, actors within meta-organizations may find identifying with the organization difficult, as their employing organization and the issue itself competes for their attention. Moreover, as meta-organizations are numerous in the digital field, virtual interaction further inhibits the formation of a collective identity (Turco, 2016). In light of this problem, organizational leaders often ask how they can instill a coherent organizational identity when the boundaries of the organization are porous.

Institutional leadership theory emphasizes the importance for leaders to cultivate an organization's internal consistency through a stable set of values that members may identify with (Washington et al., 2008). An organization's internal consistency or a

coherent organizational identity is important because the innovation of proto-institutions in a digital context often occurs through decentralized interactions, as decentralization offers flexibility to organizational members and grants the individual autonomy necessary for emergence to occur (Miller & Page, 2007). Accordingly, a lack of face-to-face interaction and coordination may preclude organizational members from identifying with the organization (Wiesenfeld et al., 1999; Turco, 2016). Specifically, organizational identification refers to how an individual perceives themselves in relation to the organization (Hogg & Turner, 1987) and often motivates members to contribute effort and resources to accomplish the organization's goals (He & Brown, 2013). In this manner, DiverseCS leaders often do not feel like they belong to the organization. Indeed, one DiverseCS leader does not identify as a member of DiverseCS during community outreach events, opting instead to use their university title. Responding to these difficulties, organizational leaders have spent great effort to enable the formation of a collective identity.

While virtual interaction may pose challenges for organizational identification, information technology may also facilitate the *formation* of an organizational identity (Gal et al., 2014; Weisenfeld et al., 1999). Virtual employees increase their identification to the organization through electronic communication (Weisenfeld et al., 1999). Additionally, Gal and colleagues (2014) contend that information technology facilitates social exchange relationships among collaboration partners that alters each organization's identity. From this perspective, organizational identity is intrinsically relational, the identity of an organization's collaborators impacts that organizations' identity. Patterns of communication, mediated through information technology affords opportunities for

members to construct an organizational identity. In this light, DiverseCS leaders use information technology to foster an organizational identity through the implementation of *layered technologies*. For example, organizational leaders use monthly conference calls to discuss routine information relevant to the functioning of the organization, monthly newsletters to promote the efforts and successes of local DiverseCS chapters, and email for routine information and informal communication. The implementation of multiple forms of information technology cements organizational leaders and members into the interactional routines of the organization, ensuring that members remain up to date about the functioning of the organization and effectively communicate with one another. Nevertheless, regular communication through information technology cannot sustain a coherent organizational identity.

To prevent organizational members from drifting away from the organization, organizational leaders must intersperse face-to-face communication among the virtual communication (Turco, 2016). Face-to-face interaction facilitates positive organizational outcomes such as organizational learning, teamwork, connections to peers, and motivates organizational members to continue working towards the organization's goals (Turco, 2016). Leaders of DiverseCS create a social space for intense interaction through their annual conference. Organizational members often spoke of how attending the annual conference gave them the "energy" to continue their efforts towards innovating new diversity practices. Although the conference consists of formal sessions where speakers are able to hare both their social and technological innovations, informal social interaction allows organizational members to interact with peers, learn, and collaborate.

Indeed, many new projects promoting diversity in computer science education arise from informal interactions among DiverseCS members at the annual conference.

Many DiverseCS leaders and members express a desire to be a part of "something big," or for their actions to contribute to a greater good. From this perspective, organizational leaders facilitate the formation of a collective identity by articulating a vision of grandiosity. For example, within a meta-organization, leaders often remind members that they are one component among a larger effort. By contextualizing member's actions and experiences as contributing to a larger organizational effort, leaders enable members to co-construct an organizational identity. Similarly, leaders often construct organizational narratives that reflect the grandiosity of the organization's actions by placing heroic individuals against magnificent backgrounds and settings. For example, DiverseCS narratives often portray student members interacting with CEOs and other powerful people or overcoming adversity in larger-than-life settings.

Organizational leaders also articulate a vision of grandiosity by demonstrating how local actions affect macro-level outcomes. Translating routine organizational practices into the primary goals of the organization can often inspire commitment and feelings of belongingness with the organization (Carton, 2018). For example, Carton (2018) describes how NASA administrators during the 1960s mobilized the action and commitment of all organizational members, orienting the collective meaning of their work towards putting a man on the moon. From this perspective, a janitor's tasks were not to simply remove trash from waste receptacles or mop the floors, but rather those actions helped put a man on the moon (Carton, 2018). In this manner, DiverseCS leaders frequently explain how organizational practices of outreach events contributes to the lofty

goal of diversifying computer science by illustrating to their members how the outreach event, while relatively small in nature, ameliorates inequality all along the computer science pipeline.

A coherent organizational identity also reduces conflict among organizational members and stakeholders, exerting an amplifying effect on interactional patterns. Organizational members often express passion and interest about issues in the digital field. They frequently align their work activity to pursue goals that extend beyond the boundaries of the organization's purview. Accordingly, organizational leaders and members devote substantial resources to their work tasks. They also ignore minor conflicts with others that may derail actions. For members of DiverseCS, the overarching goal of computer science diversity contributes to the formation of inter-organizational collaborations, as each party went beyond the formal requirements of their jobs to conduct outreach events for minority students. This commitment to diversity also prompts collaboration partners to mutually ignore or quickly resolve conflicts that may occur during collaboration. Leaders must ensure that the organization's identity aligns with the issue of the field, while also maintaining a unique organizational identity. Commitment to addressing a shared issue reduces conflict that may exert a destabilizing tension on joint organizational efforts, increasing the possibility of emergent proto-institutions.

In summation, in order to instill and maintain an organization's internal consistency in a digital milieu, organizational leaders must balance virtual and physical interaction. Virtual communication may impart routine information to organizational members, while face-to-face interaction fosters a sense of belongingness and promotes

identification (Turco, 2016). Communication within the same physical social space orients organizational members to the organization. Leaders must also ensure that the organization's mission, vision, and values incorporate aspects of the issues that organizational members express passion towards. In this manner, organizational leaders must use information technology as both a tool that facilitates interaction and also recognize how information technology contributes to the creation and maintenance of an organizational identity.

Network brokerage

In addition to crafting an organizational identity, leaders also promote proto-institutionalization by engaging in network brokerage. Such actions serve to "foster and cultivate interdependencies within and without the organization" (Marion & Uhl-Bien, 2001: 404). Leaders that encourage interaction across the boundaries of the organization by strategically uniting individuals that possess disparate knowledge or skills often promote emergence (Carlile, 2004). Indeed, prior research documents the importance of the structural positions of actors during innovative processes (Obstfeld, 2005; Dougherty & Dunne, 2011). In this manner, an actor's position within the digital field may catalyze emergent processes.

While prior studies document how complex leaders spur interaction by enabling network building actions (e.g. Plowman et al., 2007b), in the digital field, leaders seek to create hyperlinks to organizations or online content that has a high status or receives substantial online activity. Moreover, leaders also use online resources in the digital field to promote inter-organizational learning prior to formally entering into a collaborative arrangement, enhancing the functioning of the inter-organizational collaboration.

Therefore, the digital field, while still demanding network building strategies, necessitates unique network building strategies that often cross the boundary between the physical and the virtual.

Organizational leaders often construct network connections in the digital field to proselytize nascent proto-institutions (Powell et al., 2014). In this manner, connections among websites through hyperlinks or interpersonal networks introduce "ideas and practices to various audiences, facilitating recognition among former strangers" (Powell et al., 2016: 10). Proselytization requires that actors exert influence over others by using their social and technical skills. For example, an organizational leader may construct an emotionally resonant narrative that demonstrates their proto-institution and conveys its ability to address field-level problems. In the context of the digital field, proto-institutions diffuse more widely among field participants when the actor engaging in proselytization possesses a high status. From this perspective, status arises when an organizational leader establishes a relationship with an actor that already possesses a high status. (Podolny 2005). For instance, the leaders of DiverseCS frequently seek to cultivate relationships, with external funding sources, such as for-profit organizations. Such relationships within DiverseCS receive much attention and are widely celebrated as a source of pride. Leaders also establish relationships with certain non-profit organizations that are known for their efforts of diversity initiatives in computer science education. Leaders often create hyperlinks between their websites and other high-status organizations to express deference towards them. In this manner, leaders hope to diffuse their institutional practices among other actors within the digital field by prominently displaying their high-status affiliations.

Other websites in the digital field, such as Code.org, attain influence due to the content on its webpages. In the digital field of computer science education, websites that contain vast amounts of education resources, such as lesson plans, information about educational technologies, research results about diversity issues, and educational activities, receive much attention. The quantitative network analysis demonstrates that there are several websites that wield substantial authority and status in the digital field. Leaders, therefore, often include hyperlinks to such organizations on their own webpages along with other *resource websites*. In this manner, constructing hyperlinks confers status to organizational actors in the digital field, facilitating their efforts of proselytization, as audiences are more likely to be attentive of the actions of high-status associations (Podolny, 2005).

During proto-institutionalization, organizational leaders seek to establish relationships with representatives of other organizations in the digital field. For example, some DiverseCS leaders identify potential collaboration partners due to their strategic location within the field. A high-status organization or an organization that is well known for its wealth of information about diversity practices may complement ongoing proto-institutionalization efforts. This perspective is consistent with prior findings of inter-organizational collaborations that demonstrates collaborative arrangements benefit from complementary knowledge and resource stocks (Majchrzak et al., 2015). Nevertheless, DiverseCS leaders do not explicitly discuss seeking partners that are dissimilar to themselves, although such interactions contribute to emergent innovations (Dougherty & Dunne, 2011).

Although organizational leaders frequently express the need to strategically meet a particular person or representative of an organization due to their shared interests, professional demands often inhibit their ability to cultivate such interpersonal relationships. Actors in the digital field often claim membership to multiple organizations that require varying amounts of work activity. Rather than spending time developing strategic relationships, organizational leaders collaborate with individuals within their personal networks and local communities. For example, DiverseCS leaders frequently contact a child's former teacher, or a professional colleague to initiate the formation of an inter-organizational collaboration. Collaboration, therefore, occurs within an organizational leader's local community. Such local collaboration allows organizational members to experiment with proto-institutions through face-to-face interaction (Powell et al., 2016). As such, DiverseCS leaders often emphasize the importance of entering into a school or community organization and exacting positive change by implementing their nascent proto-institutions. In this manner, by experimenting with proto-institutions in a physical space organizational, leaders foster organizational learning (Turco, 2016), increasing the potential for radical and emergent innovation.

Organizational narratives

Narratives consist of sequences of interrelated events that portray settings, characters, and plots (Teeter & Sandberg, 2017). Narratives direct attention to important organizational values, goals, and symbols, providing individuals with a lens to understand tacit organizational practices and their meanings (Rhodes & Brown, 2005). To facilitate meaning making among organizational members, narratives often invoke specific organizational events or "heroic" individuals that may be emotionally resonant, inspiring

organizational members to mobilize their work efforts to achieve organizational goals (Gabriel, 1995). Moreover, through heroic tales, organizational leaders translate an organization's identity into material practices for other organizational members (Brown, 2006). Taken together, narratives convey the subjective nature of organizing (Brown, 2006), significantly affecting organizational actions (Gabriel, 1995).

Proto-institutionalization requires that actors communicate with individuals or organizational actors with whom they may not share a common perspective or understanding. While the network building strategies of leaders convey the importance of erecting "conversational bridges" to other actors (Powell et al., 2014), the strategies that facilitate communication also affect the process and outcomes of proto-institutionalization. To facilitate communication and develop an emergent system of meaning that actors participating in proto-institutionalization may use, organizational leaders employ strategic discourse (Boal & Schultz, 2007). Strategic discourse allows leaders to engage in the micro-process of correlation (Uhl-Bien et al., 2008). Specifically, correlation refers to the emergence of a common meaning system among the members of a social system (Marion & Uhl-Bien, 2001). To enable emergence, leaders must engage in sensemaking and sensegiving so that organizational members – within and beyond the boundaries of the organization – can translate and understand changes within the organizational environment (Carlile, 2004). Organizational leaders frequently rely on narratives of heroic acts to make sense of collective efforts of proto-institutionalization. Such narratives catalyze interaction, increasing the interdependency and complexity within the organizational environment (Boal & Shultz, 2007). The sharing of narratives

is, therefore, a central component of proto-institutionalization endeavors by organizational actors.

Leaders that engage in storytelling as a part of institutional work frequently construct narratives of "heroic" acts, meant to mobilize action within the organization to produce proto-institutions. As these narratives are told in an organizational context, a master narrative emerges that orients action (Trethewey, 2001). From this perspective, heroes embody institutional ideals and their actions signal important values for organizational members and stakeholders. DiverseCS leaders frequently speak of heroes that overcome challenges regarding diversity in the context of computer science. For example, Andy provides a narrative that describes how an African American child, overcoming ridicule from her classmates, drew admiration from her teachers by proposing a solar-powered hair curler. Connecting to the master narrative, Andy's narrative touts the values of diversity for computational innovation. Indeed, much of the work of DiverseCS seeks to support this master narrative.

Plots that portray heroes are common among the narratives told by DiverseCS leaders. These narratives frequently depict DiverseCS student members or children that participate in outreach events as protagonists. Accordingly, narratives that tout heroic individuals and their actions demonstrate the value of emergent proto-institutions to others. Indeed, DiverseCS leaders often share narratives with collaboration partners to increase their enthusiasm and commitment to future outreach events. Narratives, therefore, not only communicate important values and symbols for the present, but also articulate the importance of future actions (Chreim, 2005).

Sharing narratives in a virtual context also contributes to the preceding leadership actions that promote the development of a coherent organizational identity (Chreim, 2005). Emerging from the interviews with DiverseCS leaders, the master narrative of diversity anchors the understandings and expectations of actors in rapidly shifting and uncertain environmental conditions, typical of sites of proto-institutionalization. By being told in both a face-to-face and a virtual context, the master narrative becomes more durable, as others have greater opportunities to access it and to modify the master narrative to fit their idiosyncratic organizational context. Accordingly, Gal and colleagues (2014) find that information technology use influences the interactions that underlie the formation of collective identities. The use of information and communication technology by leaders to propagate organizational narratives similarly shapes positive, goal-oriented interaction among organization members. DiverseCS leaders frequently rely on monthly teleconference calls and newsletters to tell their narratives within the organization. Although storytelling in a static context, such as through monthly newsletters, does not necessarily prompt an immediate mobilization of action, it does reinforce the organization's identity. Exchanges of narratives among organizational members emphasizes that each member is a part of something larger than themselves. For example, knowing that colleagues at a different university, hundreds of miles away, has had a significant impact on diversity in their local community engenders positive emotions and identification with the organization.

While information technology facilitates organizational identity, the use of social media to construct narratives also transforms the process of storytelling, engendering complex dynamics within the organization. For example, at an annual meeting,

DiverseCS leaders used Twitter hashtags for attendees to share their experiences of the past year. Throughout the duration of the conference, DiverseCS leaders and members wrote short narratives about diversity, championing change, and overcoming adversity. Not only could attendees access each person's narrative on social media, but they could also share the narratives with others on their social media accounts and comment on particularly resonant stories. By using social media, DiverseCS leaders ensure that narratives disseminate throughout the organization. On social media, audience members may comment on narratives such as inquiring further about details or expressing their support. Authors of the narratives may then provide additional information. Such exchanges increase the complexity within the organization, by increasing the frequency of interaction and also by ensuring that interaction becomes more inter-dependent (Miller & Page, 2007). Social media places pressure on others to respond to content, increasing interdependency within the organization, fostering complex interactions among members (Uhl-Bien et al., 2008).

As narratives increase the complexity within an organizational context, they also become important tags (Boal & Schultz, 2007). As tags, narratives become a "symbolic reference for their corresponding message (Plowman et al., 2007b: 352). As such, narratives direct attention towards particular values, legitimizing strategies of action consistent with those values (Rhodes & Brown, 2005). Moreover, narratives facilitate the formation of organizational identity by tying an organization's past, present, and future events together into a single and coherent account of organizational action (Boal & Schultz, 2007). In this light, the sharing of narratives catalyzes interactions among organizational members, especially those members that identify strongly with the plots of

the narrative. While storytelling may increase interaction, it also aligns actions with values, uniquely altering interaction. Leaders that use narratives engage in complexity leadership by enabling interaction among individuals, rather than controlling interaction, push the organization towards the "edge of chaos" where emergence becomes possible (Uhl-Bien et al., 2008). In this light, narratives engender destabilizing tensions, such as frequent interaction, and a mixture of disparate systems of meaning. In contrast, the narratives' function as a tag ensures that interaction remains at the edge of chaos by introducing stabilizing tensions.

In addition to facilitating complex interactions within the organization (Boal & Schultz, 2007), narratives also impact the functioning of inter-organizational collaborations. A benefit of inter-organizational collaborations is that they mitigate the potential risk that each participant faces due to the uncertainty of addressing a problem in isolation (Emery & Trist, 1965). Nevertheless, collaborators remain vulnerable to opportunism from their partners. In fact, collaborations frequently fail due to perceptions of conflicting interests among partners (Gulati et al., 2012). Accordingly, conflict weakens commitment to the ongoing efforts of the collaboration, fraying inter-organizational cohesion (Doz, 1996; Riordan & Williamson, 1985). Given these considerations, governance mechanisms within interorganizational collaborations often depend on the development of norms and shared rules through interaction among the participants (Beck and Plowman, 2014; Hardy et al., 2005). Although the functioning of any organization depends on effective governance mechanisms to curtail potential agency problems, for inter-organizational collaborations these considerations are more pressing,

as unilateral interest seeking actions may garner substantial rewards and impose great harm on collaboration partners.

To inhibit inter-organizational conflict, DiverseCS leaders use narratives to structure inter-organizational exchanges in relation to issues of diversity. Specifically, DiverseCS leaders use narratives in a manner that invokes issues of diversity, to foster trust among collaboration partners. By orienting collaboration partners towards field-level issues and framing the efforts of the collaboration around particular issues, participants are willing to overlook transgressions that may occur during the collaboration. For example, when attempting to coordinate an outreach event with a local elementary school, DiverseCS leaders may share a narrative that demonstrates their commitment to student development, emphasizing their common interest in positive student experiences. Moreover, narratives of success and overcoming adversity cultivate anticipation among collaboration partners, who wish to witness such positive student outcomes for themselves. In this manner, narratives promote the interactions that contribute to the development of norms within the context of the inter-organizational collaboration, ensuring that the activities of collaboration participants are aligned and that conflicts and miscommunications do not significantly affect the functioning of the collaboration.

Leaders use narratives for multiple purposes to further efforts of proto-institutionalization. Narratives are especially important in meta-organizations (Gulati et al., 2012), where face-to-face interaction may be rare, as they facilitate sense-making and the formation of a collective identity. Through narratives, leaders are able to guide interaction within the organization and also define important values and identities. From

this perspective, storytellers possess substantial influence over future actions within the organization. Leaders may use the discursive strategy of narrative construction and sharing to advantageously position themselves and their organization vis-à-vis other field members. Moreover, by sharing narratives that emphasize heroic actions, leaders alter the patterns of interaction among individuals, increasing the likelihood that proto-institutions will merge from the complexity.

Overarching leadership action

While the structural properties of the digital field – path length, clustering, and degree – influence the possibility of action, the actions of leaders directly enable the emergence of proto-institutions. The preceding discussion suggests several broad themes regarding how leaders facilitate proto-institutionalization. Interaction in the digital field is often ambiguous, as individuals may claim membership to multiple organizations that pursue related or unrelated goals. Additionally, interaction occurs frequently and rapidly, often without the context of face-to-face interaction. To address these issues, organizational leaders frequently seek to encourage interaction that fosters the development of a collective organizational identity, using information technology and social media. Leaders also empower organizational members to create narratives that champion organizational heroes and their actions. Such narratives foster identity formation by illustrating how members are a part of a proto-institutionalization effort that is much larger than their own experiences. Narratives also further increase complexity by catalyzing interaction, inspiring individuals to experiment and craft novel institutional practices. Finally, leaders promote interaction in the organization and the digital field by combining their personal and professional networks with their attempts to strategically

construct inter-organizational networks of organizations that may contribute to efforts of proto-institutionalization. Each of these three leadership actions share two common elements that increase the likelihood of the formation of proto-institutions – boundary spanning and promoting interaction among actors. This recognition prompts the following propositions:

P4: Leadership actions that bridge physical and virtual boundaries by combining disparate systems of meaning and connecting disparate actors enable the emergence of proto-institutions.

P5: Leadership actions that encourage frequent, recurrent, and interdependent face-to-face and virtual interaction enable the emergence of proto-institutions.

Proto-institutions emerge from interaction that occurs in both a physical context and a digital context. Propositions 4 and 5 specify the central constructs that underlie organizational leaders' efforts of enabling institutional innovation. Specifically, when leaders encourage the combination of two or more systems of meaning and frequent interaction among field participants, emergence becomes likely. Each of the preceding leadership actions (see Table 5) supports boundary spanning and spurs action within the digital field.

CHAPTER 7: CONCLUSION

Contributions to theory

The advancement of information and communication technology has had a profound impact on how organizational actors communicate and coordinate activity, making possible novel forms of organizing (Zammuto et al., 2007). Whereas expressions of power, status, and personal interest were once reserved for face-to-face interaction among actors in product markets or corporate boardrooms, in the "digital age," the use of information technology, such as social media or online search engines, shapes the actions of organizational members. In fact, for some organizations, information technology such as social media, has become an inseparable component of the organization's structure, forcing scholars to reconsider fundamental organizational processes (Turco, 2016). Such examples of how information technology affects organizing are replete among present-day organizations. Nevertheless, management scholars have been slow to incorporate information technology into their theoretical research programs. This neglect has left central, explanatory constructs of several theoretical traditions, such as institutional theory, as relics of a foregone era, no longer reflecting the realities of contemporary organizational life (Powell et al., 2016). In addressing this theoretical shortcoming, this study acknowledges that contemporary social actors are also virtual actors. From this perspective, virtual interaction uniquely structures organizational action, significantly, influencing how organizations engage in institutional processes.

This study introduces the digital field, as the context of virtual interaction, to the organizational science literature and explains how the digital field uniquely channels and shapes action within organizations. As actors use information technology and social

media to engage with societal or organizational issues, a digital field coalesces around the focal issue. The digital field consists of websites, blogs, information resources, virtual tools, and social media accounts. When actors access information on a website or post a message on a social media account they partake in the structuration of the digital field (Jones & Karsten, 2008). For example, creating a hyperlink to a collaboration partner's website or uploading a video on social media alters the structural arrangement of the digital field. On the other hand, the digital field influences how actors construct meaning and subsequent interactions with other actors and technology (Daniels, 2018). As information technology use enables complex behavior (Beck et al., 2018), the technical properties of the digital field facilitate the emergence of higher-order social structures that engender institutional innovation. In this manner, structuration occurs in a more diffuse social context than previous studies demonstrate (e.g. Barley, 1986). Moreover, Gidden's (1984) duality of structure becomes a central social construct in the digital field, where structuration processes may occur by millions of people constantly. Figure 14 demonstrates some of the effects that structuration processes have on social interaction. Specifically, stabilizing and destabilizing tensions mediate structuration processes by moving the social system to different regions of complexity (e.g. equilibrium or chaos). This study, therefore, presents a more dynamic view of technological structuration.

More broadly, this study contributes to organizational theory scholarship by exploring how information technology influences organizing processes by demonstrating the complex nature of virtual interaction, addressing previous calls to consider how information technology influences processes of organizing (Zammuto et al., 2007). From

this perspective, organizational action occurs as the result of the interplay between the virtual and the physical.

By placing information technology into the theoretical foreground, this study sheds light onto how proto-institutionalization – the creation of novel institutional practices – occurs in a digital milieu. While prior studies document the virtual nature of proto-institutionalization (e.g. Powell et al., 2014; Korff et al., 2015), these scholars neglect the micro-macro links that enable proto-institutions to emerge. Proto-institutionalization requires actors to skillfully construct and manipulate technological artifacts, such as blogs or organizational websites. Websites that contain information and convey visually appealing graphics often gain a central position within the digital field. For example, code.org, the most central website in the computer science education diversity digital field has a website that contains multiple forms of information in a colorful and interactive format. In addition to technical skills, actors also must wield the social skills to engage in a dialogue with others from different institutional spheres and to inspire others to contribute resources to addressing the organizing issue of the digital field. Additionally, actors that seek to coordinate activity within the digital field must forge a collective identity that orients and channels action. Such social skills facilitate both the construction of digital content and face-to-face interaction. Accordingly, this study speaks to the micro-level interactions that underpin proto-institutionalization by demonstrating how organizational leaders enable efforts of social innovation. In contrast, this study reveals that leaders may constrain proto-institutionalization by limiting interaction via information technology, either by eschewing the use of information technology entirely or by minimally using information technology. Structuration

processes occur in a linear and predictable fashion with minimal technology use, whereas, frequent, interdependent technology use destabilizes interaction, engendering complex dynamics. From this perspective, the degree of technology use and how actors use technology influence the pace of structuration, extending structuration theory.

Understanding the role individual skills play during proto-institutionalization also puts into focus the balance between collaboration and contestation in the context of institutional work. While an emphasis on collaboration ostensibly highlights important mechanisms of proto-institutionalization (Lawrence et al., 2002; Powell et al., 2014), proto-institutionalization also occurs through the expression of actors' personal interests and competitive organizational forces (Fligstein & McAdam, 2012). Organizational actors often combine altruistic and personal motivations when engaging in the creation of novel social practices. Leadership actions, such as network enhancing strategies and the use of narratives, address a larger organizational issue, in the context of competing motivations. Such leadership actions often consolidate organizational power and status, while also seeking to improve the organization's position within its field. Collaborative forces and consensus building, therefore, are only one aspect of proto-institutionalization. Future studies need to turn attention to how competition enables proto-institutionalization and the interaction of collaboration and contestation.

By providing a more complete theoretical portrait of proto-institutionalization and by highlighting how information technology impacts institutional processes, this study makes several contributions to the organizational science literature. Moving beyond mechanisms of stability, recent institutional scholarship seeks to address field-level dynamics, such as field formation or the genesis of institutional practices (e.g. Powell et

al., 2016; Leibel et al., 2018). This study contributes to this effort by articulating a theoretical framework that describes the digital field as a complex socio-technical structure. Complexity science's focus on emergence and mechanisms of change complement neo-institutional theory and offer an explanation of the radical, non-linear institutional change that often produces proto-institutions. Although previous studies note the occurrence of radical change (Greenwood & Hinings, 1996), complexity science is particularly useful to explain the transition from one state to a qualitatively different state (Miller & Page, 2007; Kauffman, 1995), as in proto-institutionalization (Lawrence et al., 2002). This study takes the first step in this direction by documenting the complex network structure of the digital field, suggesting that the use and accessibility of information increases the likelihood radical institutional innovation.

Additionally, by considering how organizational leaders foster the emergence of novel social practices, I contribute to previous qualitative studies of complexity (e.g. Plowman et al., 2007a; Beck & Plowman, 2014). In this vein, I find that three organizational processes facilitate complex interactions among organizational members: network enhancing strategies, narrative construction and propagation, and building collective identities. This study is the first to explore how information technology use influences these institutional processes. Prior studies of organizational complexity rarely acknowledge the role of technology as a facilitator of emergent phenomenon (see Beck et al., 2018); however, this study demonstrates that the use of information technology can catalyze emergent organizational change, especially interaction on social media platforms. Information technology can increase the interdependence of actors and of information within an organizational system, thereby, catalyzing the efforts of

organizational members during their interactions with others, making emergence likely to occur.

Managerial implications

The recognition that information technology influences the actions of organizational leaders and members during proto-institutionalization holds many implications for practice. Specifically, leaders may use certain actions, such as skillful communication on social media, to manipulate their structural position vis-à-vis other organizations in the digital field to gain sustainable competitive advantages over their rivals. From this perspective, the digital field affords opportunities for strategic mobility. While leadership scholars generally emphasize the importance of domain-specific technical expertise for leader-member relations (Avolio et al., 2009), no leadership theory addressees the importance of the ability to strategically manipulate information technology. In this light, those conducting traditional leadership workshops and who seek to foster leadership development may wish to emphasize the use of information technology and social media, particularly detailing how technology alters important leadership characteristics. Some skills may become more difficult to use in a technological context. For example, subtleties in speech are much easier to detect in face-to-face interaction than are subtleties in a social media post. Nevertheless, by integrating how to effectively use information technology, leaders can prepare to better interact with a rapidly changing organizational environment driven by technological advancements and issue fields.

Beyond, incorporating skills germane to technical knowledge in the context of leadership development and training, the results of this study also suggests that

organizational leaders embrace their role as institutional leaders of their organization. According to institutional leadership theory, leaders infuse their organization with value, cultivating an identity that reflects societal values and norms (Selznick, 1957). Through a value-laden identity, an organization receives support and legitimacy from customers, exchange partners, and the state. Through the use of technology, however, information is much more readily accessible than in past decades, potentially making organizational identity more difficult to shape. For example, social media often becomes an arena to debate and discuss instances of corporate malfeasance, where possibly millions of people view information and interact rapidly with each other (Ince et al., 2017). To address the potential challenges that accompany the democratization of information, organizational leaders must develop communication skills. The ability to leverage a social media account or to manipulate the presentation of graphics on an organizational webpage contributes to the formation of an organizational identity and may alter an organization's position relative to its competitors. An organizational identity is important when interaction among organizational members occurs virtually. Absent a coherent organizational identity, such interaction may leave members feeling disconnected from the organization. The role of leadership is to both ensure that they instill the organization with a coherent identity for members that frequently rely on virtual interaction and that they position their organization's identity, through the strategic use of social media, websites, and blogs, to accrue more resources than their competitors. In this light, leaders not only infuse the organization with social value, but also with technological sophistication and strategy.

The digital field also holds implications for product innovation, particularly in the context of ecologies of complex innovation (Dougherty & Dunne, 2011). In ecologies of complex innovation, knowledge is dispersed among organizational actors. Innovation depends on inter-organizational collaborations that combine disparate knowledge, where the accessibility of knowledge underlies the efficacy of the collaborative effort. If informational asymmetries preclude one or more organizational actors from gaining critical information then the joint effort to innovate is likely to fail. The digital field offers a complementary perspective to knowledge sharing in ecologies of complex innovation. The digital field, as a repository of information, may facilitate knowledge sharing among multiple organizational actors in disparate institutional fields. Rather than communicating with collaboration partners, actors may instead use the digital field, either through the World Wide Web or an intranet to deposit and curate knowledge repositories or hubs. Knowledge, therefore, becomes a common resource that all organizations in the ecology contribute to and use.

As organizational actors incorporate the digital field as a strategic resource to foster a collaborative inter-organizational environment, they also may also move their collaborative system from equilibrium, moving towards the region of emergent complexity (Beck et al., 2018). As information is a crucial component for emergent processes (Miller & Page, 2007), the interaction with the digital field may increase the degree of complexity within inter-organizational relationships. Extant theory and the qualitative results of this study suggests that information technology may engender complex interactional patterns among organizational actors. Managers and organizational leaders, therefore, must be attentive to this function of information technology,

harnessing the technology when emergence may result in positive organizational outcomes.

Limitations and Future Research

This study, like all research endeavors, is not without limitations. Although a mixed methods research design mitigates many points of weakness that any single method may bring to bear on a research project, this research does have areas of potential concern. Particular limitations are twofold and include the sample of websites and hyperlinks obtained for the network analysis and the sampling frame for the qualitative interviews.

The first limitation is that the hyperlink network, capturing the digital field, only reflects organizations that have a presence on the World Wide Web. Powell and colleagues (2014) contend that hyperlinks represent conversational bridges between organizations and that online activity is a prevalent form of contemporary organization's channel of communication, however, the possibility remains that organizational leaders and members form collaborative ties with other organizations and leave no online indicators of this activity. The qualitative results partially address this concern. Specifically, although leaders of DiverseCS often do not explicitly use hyperlinks to indicate an ongoing collaboration, there are other reasons to include a hyperlink on their website, such as to direct others to information or to indicate a philanthropic source of finding. From this perspective, there is substantial overlap between the composition of the digital field and interaction in the physical world.

Nevertheless, it is unlikely that the sample of hyperlinked websites will reflect all organizational activity surrounding a single issue. In fact, the DiverseCS leaders often

mentioned collaborations that were not captured by the network data. Drawing on Fligstein and McAdam's (2012) theory of fields, I argue that the digital field and the organizational field are separate constructs. Membership in one field does not necessarily include membership in the other. For instance, one may belong to the organizational field surrounding environmentalism by joining Green Peace and not engage in any virtual activity regarding environmentalism. In this light, the digital field does not mirror the organizational field. As such, the digital field interacts with the organizational field, which requires further research to elucidate the underlying points of connection and unique theoretical mechanisms that shape organizational action through both constructs.

The use of a web crawler also presents certain challenges for data collection that may affect the results of the network analysis. For example, of the 23 seed websites (see Table 1) 21 of those websites remain in the top 23 websites according to their degree. This finding may be because the seed websites were selected as websites that are central to the field of diversity in computer science education. From this perspective, recommendations by the subject matter expert appears to correlate highly with a website's degree and is not a cause for concern because it is a true reflection of the composition of the digital field and is not an artifact of the methodology. In contrast, the web crawler does not follow as many intra-website links on websites that it discovers towards the final iterations of a web crawl. For such websites, the web crawler may only follow all of the hyperlinks on the website's primary webpage, whereas for the seed websites, the web crawler will examine the primary webpage and two additional webpages within a single website. Therefore, the difference in degree may be solely due to the sampling technique. Supplementary analysis seems to support the latter argument,

raising concerns over the use of web crawler technology in the organizational sciences. From this perspective, further research is warranted to better understand how to use web crawler technology to identify online social spaces, which may substantially alter existing organizational processes and dynamics. One such remedy is to increase the efficiency of the web crawler itself. For example, a web crawler requires resources, specifically bandwidth, to function; as bandwidth is limited, the researcher must make concessions regarding the number of webpages that the web crawler will collect. Assuming resources are not a significant constraint, the researcher could program the web crawler to follow an arbitrarily high number of hyperlinks on each webpage to prevent the under sampling of non-seed websites. Nevertheless, there are substantial benefits to using web crawler technology in the study of organizations, as concepts from social movement theory provides novel insights into organizational processes (Fligstein & McAdam, 2011).

Related to the preceding issue, the network data of this study are cross-sectional and detail only one field. This study cannot, therefore, address questions pertaining to the development of the digital field or differences between digital fields. Future researchers need to examine the structure of multiple digital fields in a cross-comparative manner. In fact, the investigation of multiple digital fields simultaneously could reveal important differences and similarities in structure across digital fields. This study cannot answer whether a digital field must possess a complex network structure for proto-institutions to emerge from the efforts of organizational actors, a cross-sectional comparison could begin to address this quandary. Another avenue for future research is the use of longitudinal data to capture how digital fields form, grow, and potentially decline. For example, Powell and colleagues (2005) document the mechanisms that gave rise to the

structure of inter-organizational collaborations in the biotechnology organizational field, a similar methodology could provide insight into the mechanisms of proto-institutionalization. Using a longitudinal framework answers several pertinent questions that are not only of theoretical significance, but also of practical significance. What mechanisms underlie the formation of the digital field; for example, is it evolutionary, complex, dialectical, or some other mechanism? What factors facilitate the development of the digital field? How can organizational leaders enable the development of the digital field? Further research is needed to better clarify these questions.

The second limitation of this study is the sampling frame for the qualitative interviews. Ostensibly, interviewing individuals who hold professorships at American colleges and universities who also receive grant monies from the National Science Foundation are not representative of organizational leaders in the wider workforce and rightly may engender uneasiness about the generalizability of this study's findings to other organizational contexts. Tracy's (2013) discussion of qualitative quality, nevertheless offers some guidance and reassurance regarding the transferability of this study's results.

Tracy reasons that the goal of qualitative research designs is not to produce generalizable results; such results are only obtainable through hypothesis testing. Rather qualitative results should be transferrable or generalizable to theory. Transferability occurs when the analyst effectively fractures the data and recombines the data in a manner that highlights theoretical relationships with clarity (Lincoln & Guba, 1985). In this manner, while the sampling frame may preclude traditional notions of generalizability from a positivist perspective, many leaders must engage in network

brokerage (e.g. Obstfeld, 2005) and sensemaking (e.g. Weick, 1995) on a daily basis. The results of this study are, therefore, transferrable to other organizational contexts, such as the innovation of non-profit performance metrics (Powell et al., 2014) or collaborative efforts to cure cancer (Lawrence et al., 2002) or many organizational contexts that depend on complex innovation (Dougherty and Dunne, 2012).

There are numerous opportunities for further qualitative research to better understand the digital field and how it shapes the actions of organizational leaders. This study provides a great understanding of how organizational leaders engage in proto-institutionalization, however, it could be possible that organizational differences exist and shape the leader's actions. For example, several DiverseCS leaders discussed how they thought that organizational size could impact how well their members are able form a sense of community and how they could coordinate work activities for outreach events. Future studies could further explore the relationship between how organizational size impacts the construction of a sense of community among organizational members. Moreover, further qualitative research that includes organizational members from multiple organizations can address dyadic relationships between organizational actors in a manner that this study cannot. For example, questions could be asked of two collaboration partners regarding how they use information technology to coordinate their activities.

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TABLES

TABLE 1: Seed websites

Website	Description (Profit Orientation and Organizational Form)
https://edu.google.com/	For-Profit/Bureaucratic
https://academy.oracle.com	For-Profit/Bureaucratic
http://research.microsoft.com/	For-Profit/Bureaucratic
http://www.ncwit.org/	Non-Profit/Bureaucratic
https://code.org/	Non-Profit/Bureaucratic
http://cahsi.cs.utep.edu/	Non-Profit/Bureaucratic
http://expandingcomputing.cs.umass.edu/	Non-Profit/Bureaucratic
http://www.cs.washington.edu/	Non-Profit/Bureaucratic
https://www.washington.edu/accesscomputing/	Non-Profit/Bureaucratic
http://www.exploringcs.org/	Non-Profit/Bureaucratic
http://cra.org/cerp/	Non-Profit/Bureaucratic
http://www.blackgirlscode.com/	Non-Profit/Bureaucratic
http://www.tapiaconference.org/	Non-Profit/Bureaucratic
http://urmc.cs.cornell.edu/	Non-Profit/Bureaucratic
http://hourofcode.com/	Non-Profit/Bureaucratic
http://ghc.anitab.org/	Non-Profit/Bureaucratic
http://computerscienceonline.com/	Non-Profit/Bureaucratic
http://k12cs.org/	Non-Profit/Bureaucratic
http://www.madewithcode.com/	Non-Profit/Bureaucratic
http://www.stemedcoalition.org/	Non-Profit/Network Form
http://www.iaamcs.org/	Non-Profit/Network Form
http://www.bdpa.org/	Non-Profit/Network Form
http://www.starscomputingcorps.org/	Non-Profit/Network Form

TABLE 2: Supplementary websites

Website
http://www.acm.org/
https://blog.csta.acm.org/2015/10/20/disrupting-the-gender-gap-in-computer-science/
http://blogs.worldbank.org/edutech/learning-code-vs-coding-learn
http://ecepalliance.org/about/alliance-members
http://www.cmd-it.org/
http://diversitycomplete.com/iaamcs/
https://twitter.com/stemedcoalition
http://www.cscproject.org/
http://www.diversityinaction.net/index.html
http://www.exploringcs.org/

TABLE 3: Top supplementary websites by degree

Website	Degree
http://www.acm.org/	285
http://blogs.worldbank.org/edutech/learning-code-vs-coding-learn	274
http://ecepalliance.org/about/alliance-members	144
http://www.cscproject.org/	60
http://www.diversityinaction.net/index.html	41
http://www.cmd-it.org/	26
http://www.exploringcs.org/	22
https://twitter.com/stemedcoalition	16
http://diversitycomplete.com/iaamcs/	5
http://www.tapiaconference.org/	3

TABLE 4. Axial codes

Codes	Description	Exemplars
Hyperlinks	Motivation for using hyperlinks and the social meaning that participants attach to hyperlinking activity	A reason to put a hyperlink on our page would be to connect folks to the organization that we're going to work with so we all know more about, maybe, the mission of that particular community organization, it may be a link to photographs from an event.
Information Technology/ Social Media	The use of information technology or social media to communicate, coordinate, or contest with other actors	We were at one of their conferences and they were using Twitter to maintain a wall of students posting tweets. That was fascinating to see how all liked tweets were helping students to get connected
Collaboration/ Local Collaboration	Coordination of work activity between two or more actors for the purpose of achieving DiverseCS goals	They're long-standing collaborations. We've been working with Girl Scouts and Girls Inc. for six, seven years, with these three main high schools for three years, some of them more because we worked with them in other capacities. It's about relationships and it's about finding ... There's no sense in forcing a collaboration.
Network Brokerage	Active manipulation of one's social network	And so ... So we had to like recruit the faculty to be involved in DiverseCS. And we had to match the faculty and the students together. All of these outreach activities that occurred we had to sort of drum up the activities. Like we had to get them ahead of time.
Organizational Identity/Community	Perceptions relating to a feeling of belonginess with the community of professionals in DiverseCS. This relates to personal and professional identity	You know you kind of have to build that sense of community and build that ... You know ... Yeah, I think that sense of community. That identity ... The DiverseCS identity you know if you don't meet you're not gonna quite have that. I don't think.

|		You may have your own individual things.
Narratives	Strategic discourse that participants use to make sense of past, present, and future events in the context of diversity practices	So, these are some of the stories that really touch and make students who are teaching feel good that, "Hey, I'm making impact on community. I'm giving them something that is really useful, that they can make use of and can give back to community based on the knowledge that I shared with them."

TABLE 5. Leadership actions of proto-institutionalization

Mechanisms	Leadership Actions Supporting Proto-institutionalization	Theoretical Propositions	Exemplar Quotes
Foster Coherent Organizational Identity	- Build community through service - Encourage virtual and face-to-face interaction - Articulate a vision of grandiosity	Organizational leaders facilitate proto-institutionalization in a digital environment by cultivating a coherent organizational identity through community building actions that emphasize service to others, value physical, informal interaction, and convey a sense of belonging to something larger	I would say then it's also about building that community because you have the old, the original DiverseCS people that are coming together, those original people that wrote proposals together, the original students that were first part of DiverseCS, the original folks that were part of planning committees, and then they're also bringing in new students. And the old students are coming back and celebrating and meeting each other. And so the meeting is the core of the identity
Network Brokerage	- Manage physical and digital networks - Incorporate the needs of external stakeholders into organizational activity - Strategically form relationships with others that provide complementary	Organizational leaders facilitate proto-institutionalization in a digital environment by expanding inter-organizational networks by responding to the needs of the community of interest and by strategically connecting with organizational actors that may provide future opportunities	We think about how do we work with city government because city government then allows us access to certain opportunities to city facilities. We think about the school district and working with principals because we wanna be able to get to students and get inside their building. And how do we partner with

			teachers that are already doing STEM, that are looking for college students?
Narratives	- Share narratives that depict organizational heroes - Craft narratives that convey organizational goals and values - Tell narratives laden with emotion to resonate with the audience	Organizational leaders facilitate proto-institutionalization in a digital environment by instilling organizational goals and values into narrative plots that portray organizational heroes and heroic acts, which resonate with audiences	So, these are some of the stories that really touch and make students who are teaching feel good that, "Hey, I'm making impact on community. I'm giving them something that is really useful, that they can make use of and can give back to community based on the knowledge that I shared with them.

FIGURES
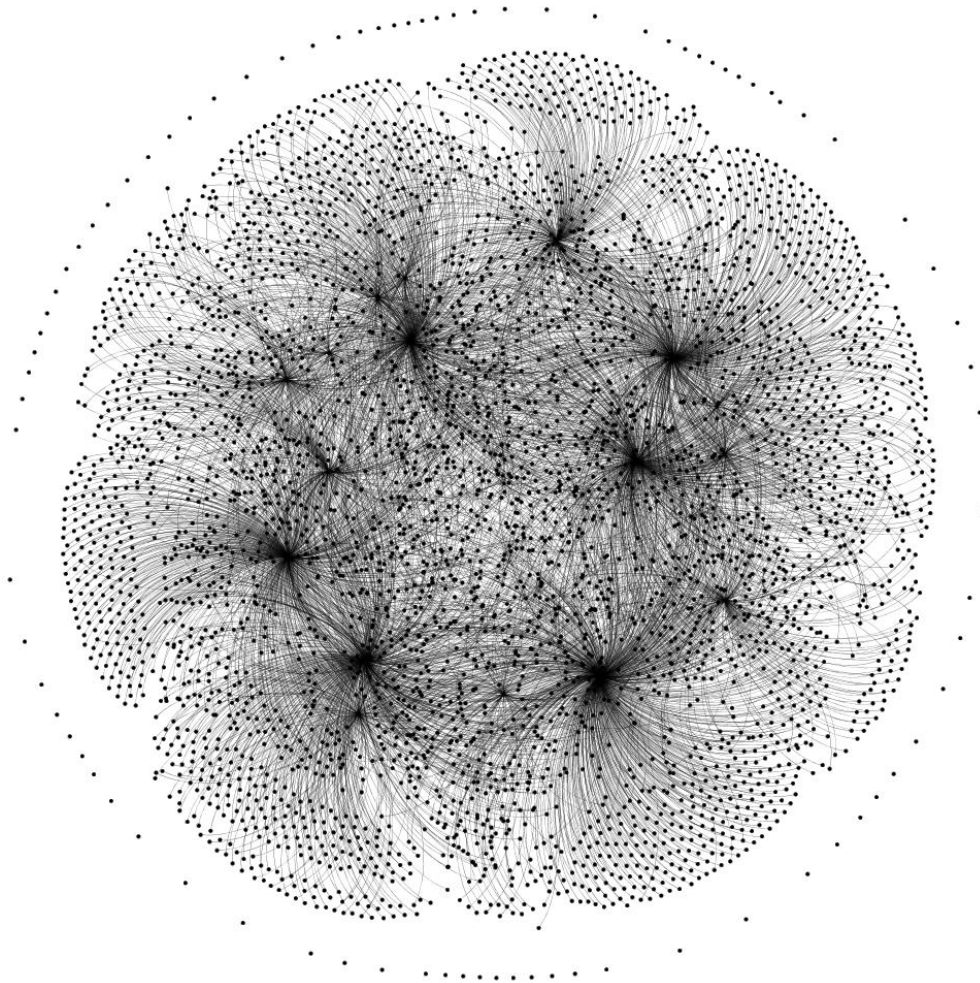
FIGURE 1: Digital field of diversity issues in computer science education
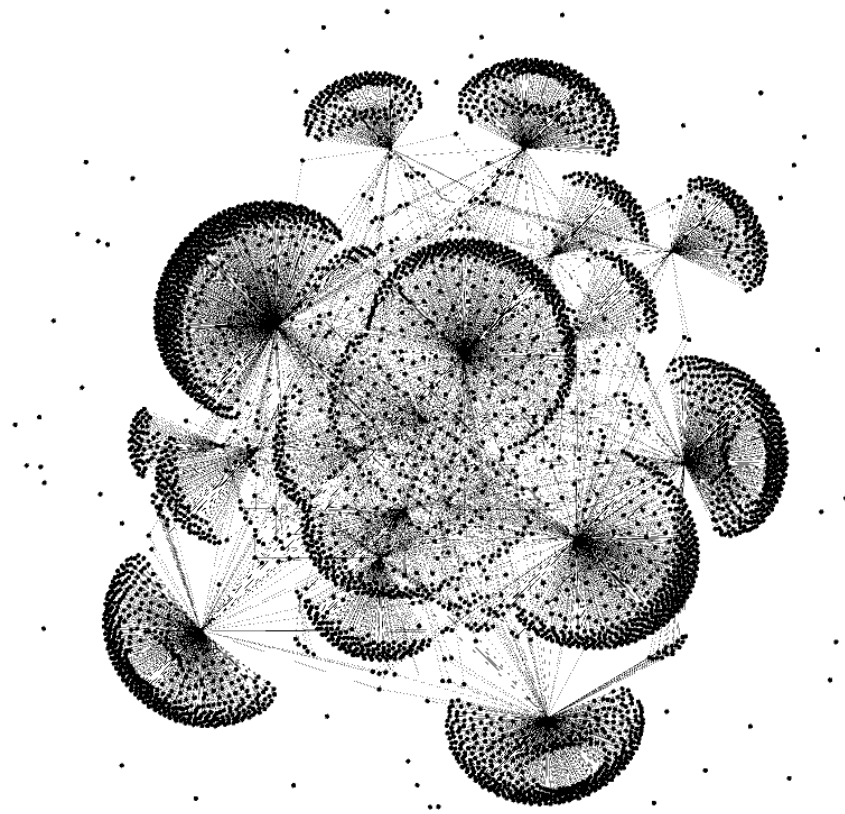
FIGURE 2: Hub structure of the digital field
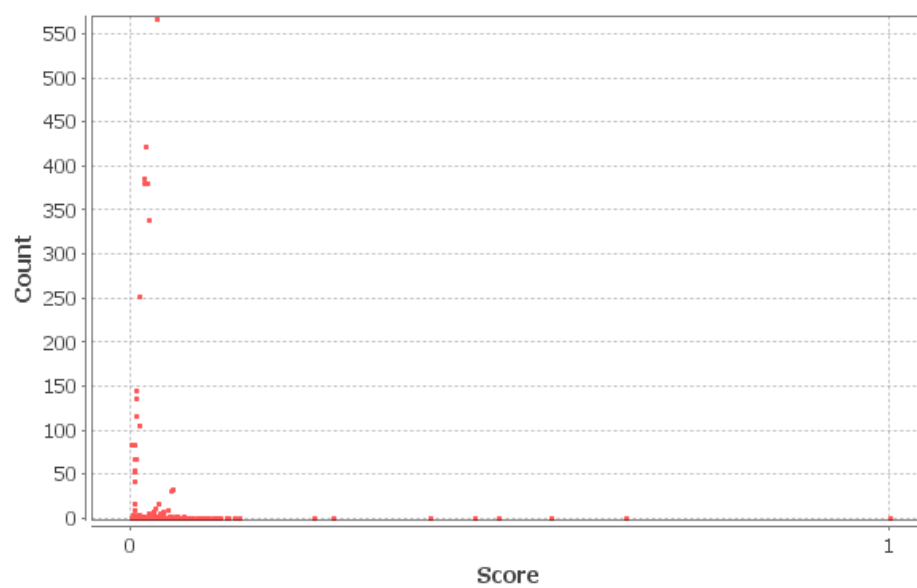
FIGURE 3. Eigenvector centrality distribution
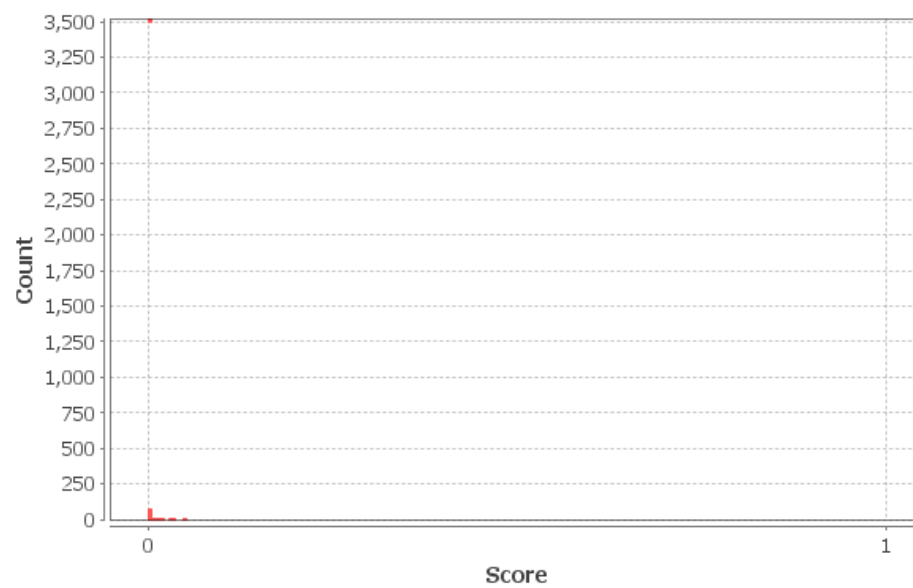
FIGURE 4: PageRank distribution
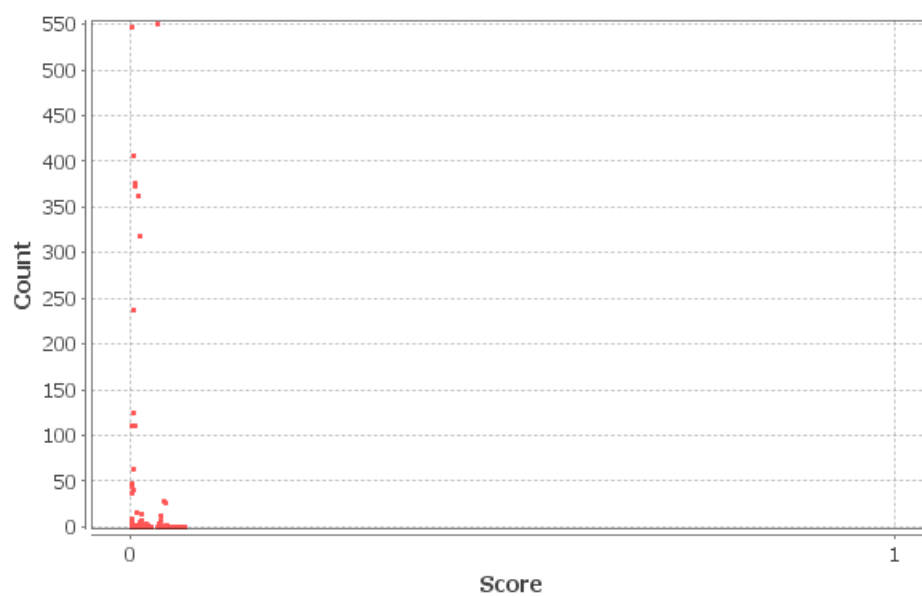
FIGURE 5: Hubs distribution
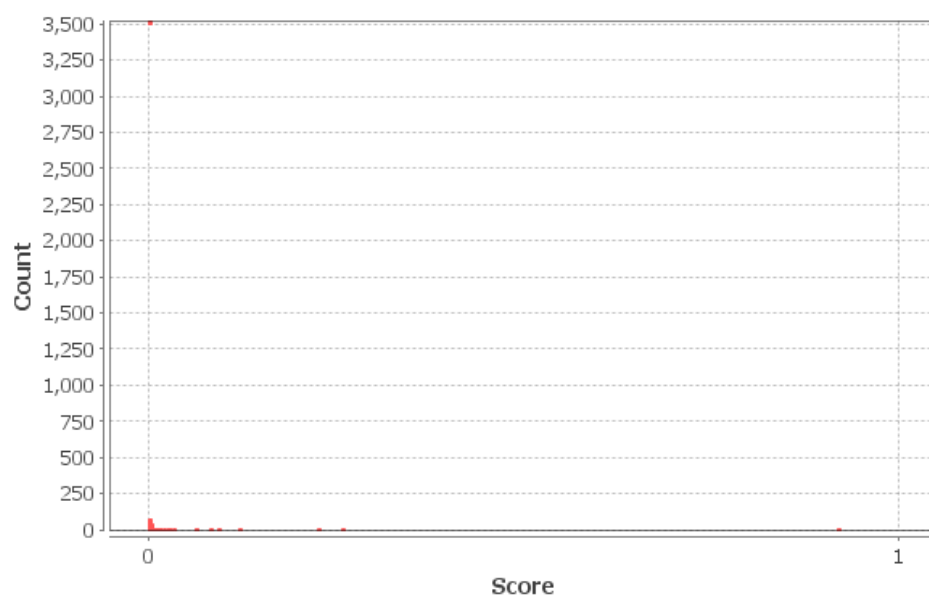
FIGURE 6: Authority distribution
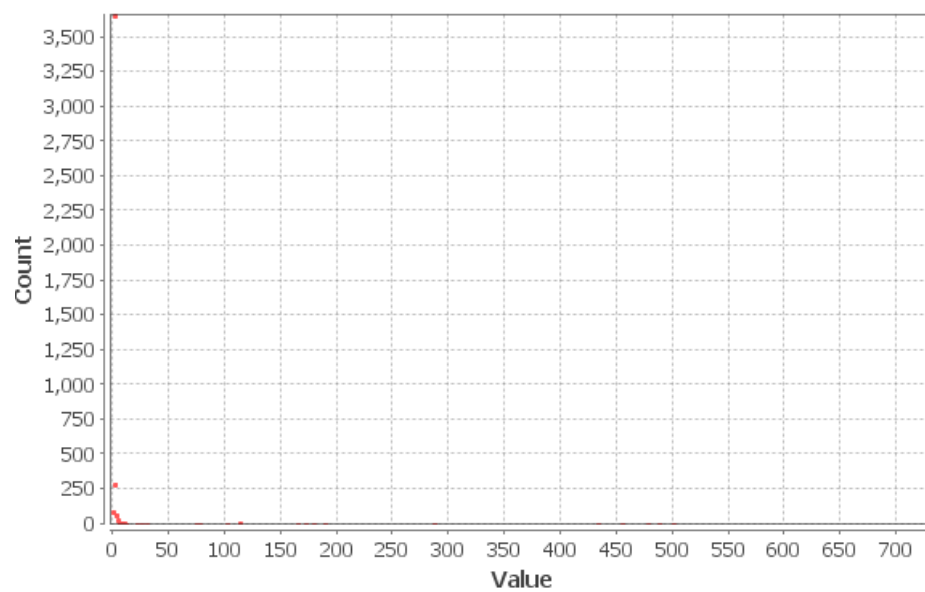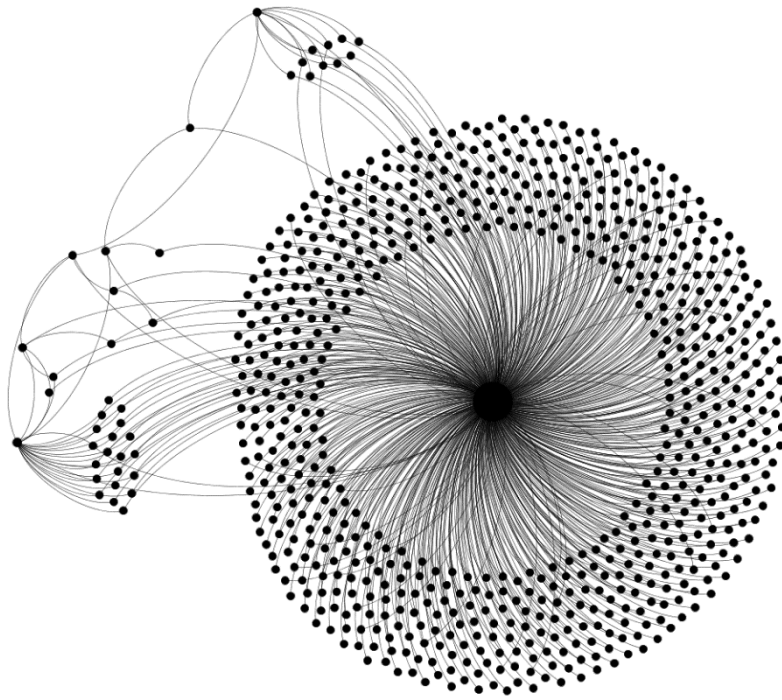
FIGURE 7: Degree distribution
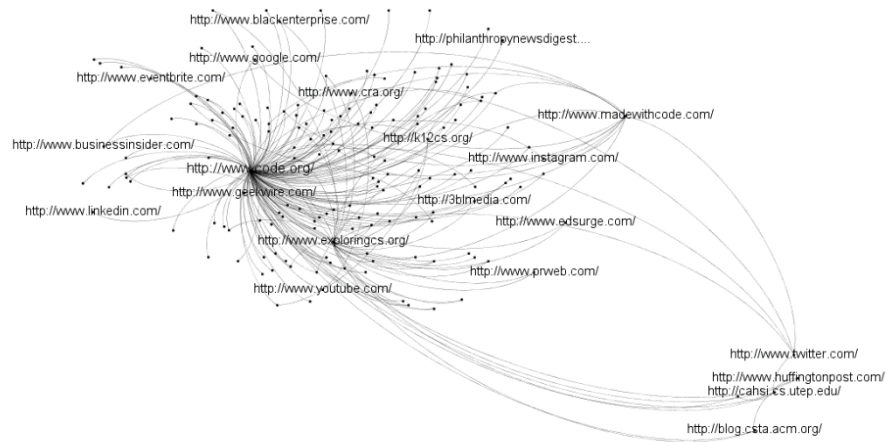
FIGURE 8: Code.org complete ego network

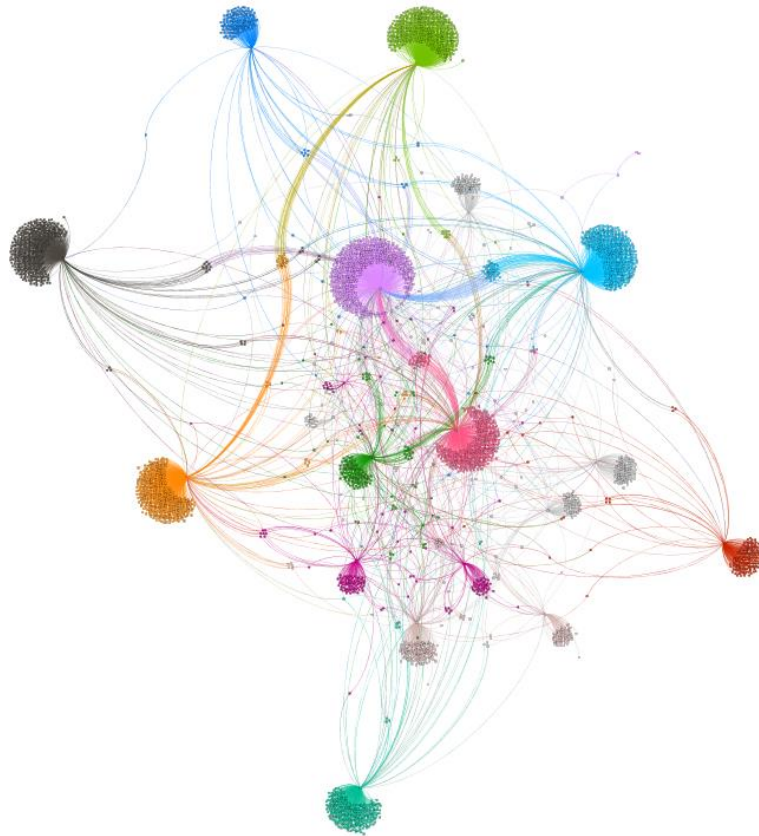FIGURE 9: Code.org reduced ego network
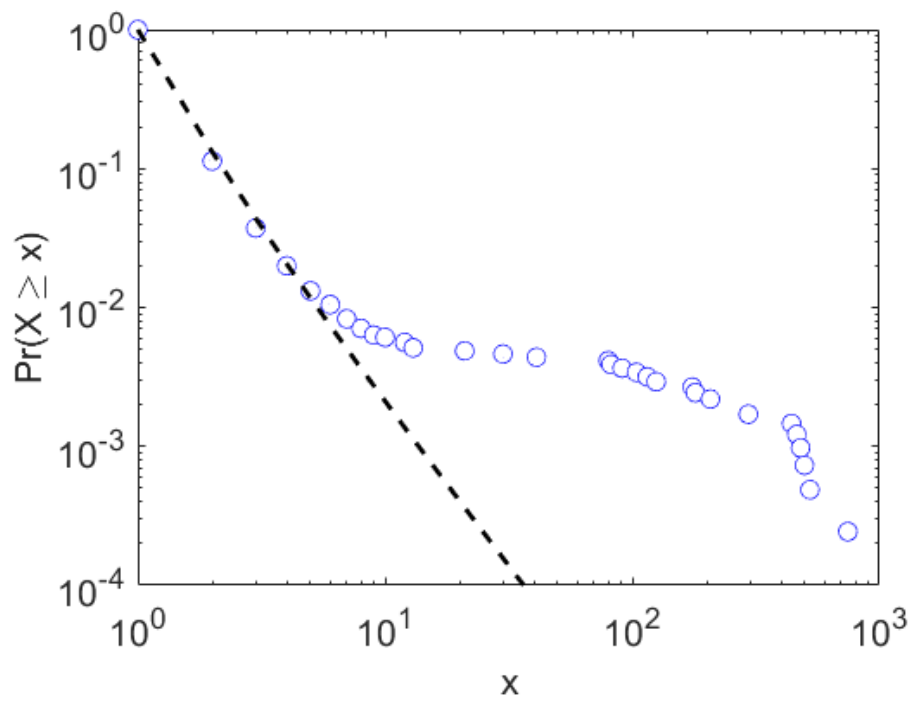
FIGURE 10: Power law plot
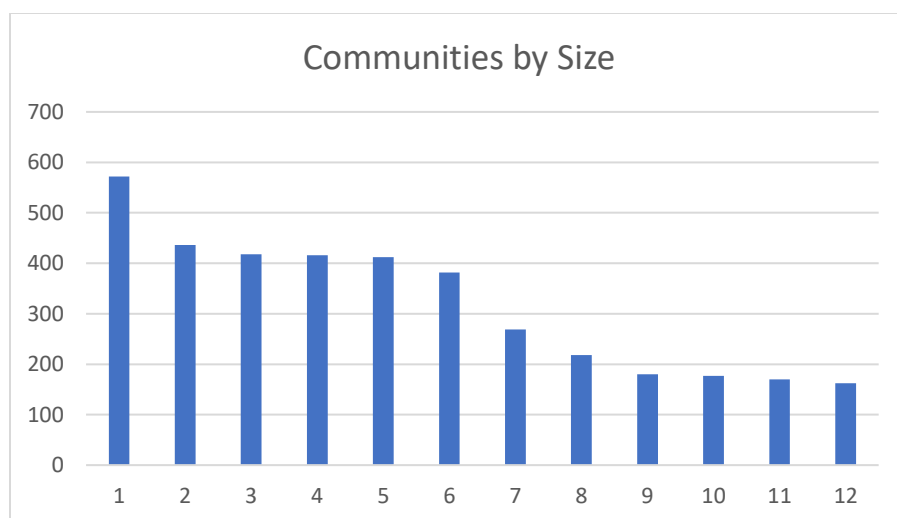
FIGURE 11: Community structure of the digital field
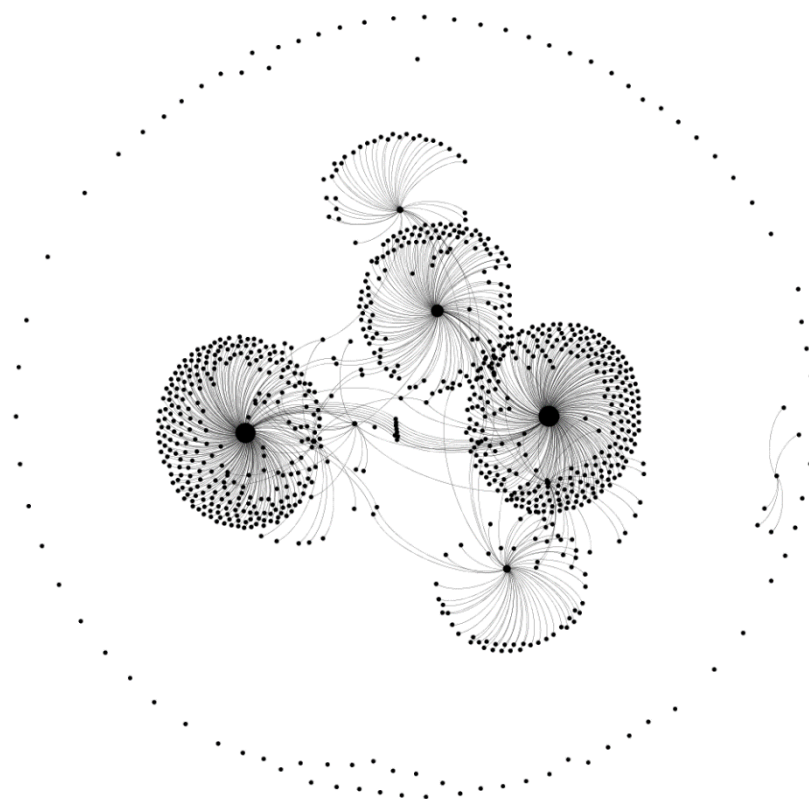
FIGURE 12: Communities by size

FIGURE 13: Supplemental hyperlink network
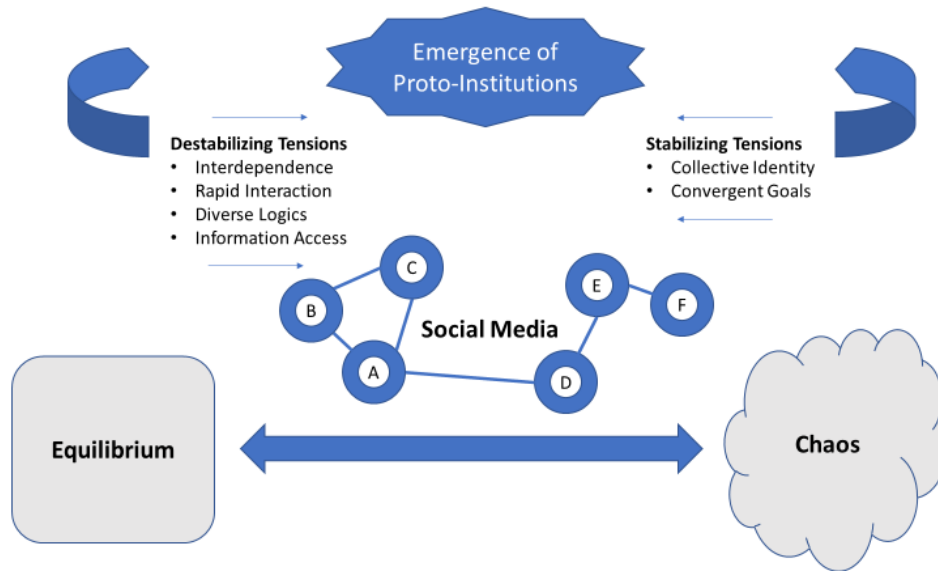
FIGURE 14. Social media as an enabler of emergence

APPENDIX: INTERVIEW PROTOCOL

Opening the Interview

Thank you for agreeing to meet with me today. We have the next hour together today. Does that still work for you? I want to honor that commitment. Therefore, while I encourage you to elaborate on your answers to my questions, there may be times when I redirect, so that we may be sure to cover all the issues within the hour. I also want to ensure that you received the letter of informed consent through email. Please remember that this interview is only for research and my utmost goal is to maintain your anonymity. Also, please remember that we can stop the interview at any time you choose; this is completely voluntary. Please do not state your name or any proper nouns that could be used to identify you. Please answer all questions honestly and provide as much detail as possible in your responses.

The first several questions are about your particular role in DiverseCS and about DiverseCS in general

1. How did you become a participant in the DiverseCS Alliance?
2. Please describe your role and responsibilities in the DiverseCS Alliance.
3. What is the importance of Celebration to the DiverseCS organization?
4. Can you tell me a bit about the DiverseCS Alliance? Specifically…
    - I know that DiverseCS is in a transition period, can you tell me about that and its effects?

The next set of questions pertains specifically to collaboration <u>within</u> DiverseCS (among other colleges and universities).

5. How do you communicate and/or coordinate with other DiverseCS members?
6. Describe some of the challenges that you have experienced in relation to communication and coordination with other DiverseCS schools.

    - How does information technology address those challenges?

7. How does information technology (e.g. video conferencing/ teleconferencing, email, virtual newsletter) contribute to successful relationships?

    - Can you describe a specific example?

8. How does information technology (e.g. video conferencing/ teleconferencing, email, virtual newsletter) create challenges or conflict?

    - Can you describe a specific example?

9. Describe how information or feedback about DiverseCS flows through DiverseCS.
10. How does DiverseCS create a sense of community among the participant schools?
11. Is social media used in DiverseCS? If so how?

The next set of questions pertains specifically to collaboration <u>within your</u> DiverseCS organization.

12. How often do you meet face-to-face with your DiverseCS students/other faculty?
13. How do you use online resources (i.e. webpages, wikis) in your role at DiverseCS?
14. How do online resources help you create or disseminate diversity practices?
15. What do hyperlinks on your organizations webpage mean or indicate?
16. How do you use social media to collaborate within your own DiverseCS organization?
17. How have you sought to sustain DiverseCS at your college/university?
18. How do you create a sense of community among your students and other local partners?

The next set of questions pertains specifically to collaboration with <u>other</u> organizations.

19. How do you identify potential collaboration partners?
20. How long do collaborations typically last and what factors contribute to collaboration duration?
21. How do you communicate DiverseCS goals and diversity practices to other types of organizations, such as businesses or very specialized non-profits?
22. What types of information technology (e.g. email, teleconferencing etc.) do you use in collaborations and how does it affect collaboration?
23. How do you use social media (e.g. twitter, facebook etc.) to collaborate with another organization or to create new diversity practices?
24. What major conflicts have occurred during collaboration with another organization?
25. Were the major conflicts resolved? If so, how and were the resolutions effective?
26. How might you increase the effectiveness of collaboration so as to enhance the coordination, cooperation, communication, and conflict management in the future?
27. How do you receive feedback or information from collaboration partners?

The final set of questions pertains to communication within the DiverseCS Alliance and with collaborative partners.
Narratives refer to important events regarding people or ideas that are important to your organization. For example, a senior leader has told me about a technology conference in Aspen, CO, a CEO of a large company was demonstrating a new piece of technology when an error occurred. A DiverseCS student member was in the audience and was able to go onstage and fix the technology issue. For DiverseCS, this narrative has become a

powerful vision of how the participation in DiverseCS by students can affect their lives by providing unique experiences.

28. Can you tell me a story or narrative regarding diversity in DiverseCS? Please be as detailed as possible?
29. How do narratives or stories facilitate communication among your collaboration partners?
30. Can you tell me about a time when an idea for a new diversity practice was not successful?

Concluding Remarks

31. Is there anything else that you would like to share or mention that you believe is important for me to know that we have not already discussed?

Thank you again for meeting with me today.