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The Use of Social Media to Foster Trust, Mentorship, and Collaboration in Scientific Organizations

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ABSTRACT

Many domains are well known for their resistance to social media. Currently, there is a dearth of literature that explores social media use in these contexts. This study seeks to help address this gap by evaluating the use of social media within a scientific organization (anonymized as SciCity) that has a strong virtual presence and quarterly face-to-face meet-ups. We evaluated SciCity's use of social media to foster trust, collaboration, and mentorship. We found that the prominent social media platform Twitter fosters trust amongst organizational members and plays a role in creating and maintaining lightweight collaborative relationships. Additionally, Twitter-based relationships often act as precursors to collaborations that occur face-to-face. However, Twitter, by itself was not found to be successful in promoting formal collaborations. Though the medium did facilitate sporadic mentoring, supplementary non-social media-based communication was needed to form mentorship relationships. Twitter was also found to serve as a 'social lubricant' (Leonardi and Meyer 2014) making contact easier and faster, thereby helping to foster a scientific social network. Though minor in its role in specifically fostering scientific collaboration, the use of social media by SciCity indicates a shift towards acceptable uses of social media for scientific organizations that have traditionally been hesitant to use social media.

INTRODUCTION

Not only has the Internet made data management easier, but it has also allowed scientists in geographically displaced areas to rapidly share their results (Olson, Zimmerman and Bos 2008). However, while the internet has increased the ease with which scientists communicate and share information, some argue that the internet has not fundamentally changed models of scientific knowledge production (Glaser 2003). Rather, advances such as online journal publication have just made it easier for scientists to disseminate research to a wider, global audience (Glaser 2003).

Computer-mediated-communication (CMC) has also made it possible for scientists to maintain virtual workbenches and share observational/experimental data with a wide audience (Glaser 2003). However,

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Kling (2000) highlights issues with receiving 'credit' for online contributions in terms of impact and posturing for grants and promotion. Some scientists see blogs, tweets, and other social media as problematic due to the lack of intellectual property protections. Thus, finding a balance between communication that facilitates the open scientific generation of knowledge and individual acknowledgment is critical. Virtual organizations in the sciences have become increasingly common and have the potential to overcome some issues such as intellectual property. They provide an important platform to bridge geographical constraints, and can act as innovative, collaborative incubators. At a basic level, virtual organizations are defined as 'groups of people with common interests and practices that communicate regularly and for some duration in an organized way over the Internet through a common location or mechanism' (Ridings 2002). Contemporary virtual organizations have come a long way and are now evaluating the potential of emergent Internet-based technologies including social media, telepresence-style videoconferencing, and custom-deployed apps (Wasko et al. 2011). Though previous research has explored new innovations and types of collaboration within virtual teams (Montoya, Massey and Lockwood 2011), there remains a dearth of qualitative work on the subject.

This article seeks to address this gap through a qualitative study of a life sciences virtual organization whose members combine social media based communication with regular face-to-face events in New York City followed by a social event. The organization, anonymized as SciCity, SciCity's encourages knowledge sharing, collaboration, and scientific innovation. SciCity is unique in its strong offline and online organizational structures. Much of its online interactions take place on the social media platform Twitter. Because tweets can be either directed or undirected, Twitter has the unique duality of being both collective and personal. In its collective form, it creates a language and basic code of conduct for all

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users to abide by (Gruzd 2011). Yet it also simultaneously acts as a perceived personal space as the user can vocalize their personal thoughts and opinions (Gruzd 2011). Depending on one's followers and tweet posting content and style, Twitter allows people to access a greater, usually weak-tie-based, audience (boyd 2010; Donath 2004; Java 2007).

This article explores whether social media and its facilitation of synchronous sociability breeds affect-based trust, providing a social foundation for catalyzing scientific collaboration and even mentorship. We ultimately found that Twitter fosters lightweight collaborations that are sporadic, brief, and informal. The medium can also facilitate the building of mentorship relationships. However, we did not find evidence that SciCity members found social media useful for formal scientific collaboration. Rather, though importantly, it serves as a 'social lubricant' (Leonardi and Meyer 2014) which facilitates contacts and interactions that can potentially lead to formal collaboration and even mentoring relationships.

Online/Offline Trust

In virtual organizations that lack face-to-face interaction, trust is essential for establishing communities and promoting social cohesion (Anderson, Steinerte and Russell 2010). Relationships developed online are often perceived as 'less close and supportive' because they usually involve less shared activities and discussions of topics which are of 'personal concern' (Mesch and Talmud 2006). That being said, there are many topics people feel hesitant to discuss face-to-face, but may feel more comfortable doing so via a virtual medium such as Twitter. This may aid the social aspects of scientific knowledge production (Collins and Pinch 1979).

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In virtual organizations, individuals are often communicating to a group, which explains how trust is formed in ad-hoc virtual teams. In some ways, the need for individual trust is replaced with the need for collective trust (Ridings 2002). Additionally, the responding interlocutor is often not chosen, but organically emerges based on ability and availability at the time. However, collective trust does not overshadow individual trust as interlocutors who, for example, provide a specific solution to a task need to be trusted at an individual level.

Trust is made up of both cognitive and affective components (McAllister 1995). Cognitive-based trust is rooted in the rational decision to either trust or not trust another individual—a decision that is based on perceived levels of responsibility, dependence, and reliability in another (Costigan 1998). Affect-based trust is rooted in the emotional relationships between people, such as the degree to which individuals demonstrate care and concern for one another (McAllister 1995). For some, cognitive-based trust is seen as more important in task-based trust formation than affect-based trust (Kanawattanachai 2002).

While it is important to understand the factors that contribute to the formation of trust, it is also equally important to understand that, like in the situation of people living together, it is ‘also impossible to maintain trust without also incorporating a substantial degree of mistrust and suspicion’ (Bengt Kristensson 2013). In many ways trust and distrust are separate constructs (Lewicki, Tomlinson and Gillespie 2006), but they are not mutually exclusive. In the same vein, an absence of trust does not necessarily indicate the presence of distrust or vice versa (Lewicki, McAllister and Bies 1998). Rather, a certain level of skepticism is important to the reflexivity in trust formation (Bengt Kristensson 2013).

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Additionally, when individuals enter into online collaborations, they may place themselves in situations where their privacy and identity might be put at risk. Yet, many virtual collaborators are aware of these potential risks, but choose to participate nonetheless. These individuals are aware of the dangers of online participation (high level of distrust) yet chose to participate anyway (high level of trust) (Jarvenpaa 2010).

Collaboration

Friend and Cook (1990) define formal collaboration as ‘a style for interaction between at least two co-equal parties voluntarily engaged in shared decision-making as they work toward a common goal’. To collaborate successfully, individuals employ a variety of strategies, such as communicating, deliberating, searching for information, collecting answers, creating ideas, and problem solving. In and of itself, collaboration must be seen as a means and not as an end (Widmark 2011). For successful collaborations, professionals must be motivated for the joint task, and they must have a common interest in collaborating (Widmark 2011). Moreover, an increase in open communication within an organization is likely to increase the amount of commitment one has to the organizational structure as a whole (Güney et al. 2012). Nevertheless, some research suggests that Twitter is not an optimal platform for organizational communication and operates best as a platform to relay organizational news (Lovejoy, Waters and Saxton 2012).

For example, Thune (2011) has classified collaboration as formal and informal and adds a temporal categorization: long-term and short-term. Formal collaboration requires a formalization of the process, viewed in “formal organizational layouts, leadership and administrative support, goals, strategies and

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role specifications for the involved participants (Thune 2011)". Long-term collaborations tend to be formal, whereas short-term collaborations are more likely to be informal (Thune 2011). Virtual collaborations have been found to usually require frequent, daily, communication, either by email or some online method, to establish a high level of productivity (Glaser 2003).

Scientific collaboration usually occurs within scientific communities that "constitute a small world, in which the average distance between scientists via a line of intermediate collaborators varies logarithmically with the size of the relevant community" (Newman 2000). With the rise of social networks and social media, some scientists have begun using these social technologies, including Twitter, to create professional networks and coordinate activities that facilitate collaboration (e.g. groups on LinkedIn and Facebook as well as on proprietary enterprise networks) (Honeycutt and Herring 2009). Generally, Twitter is used to share ideas and opinions in an informal and rapid manner (Honeycutt and Herring 2009; Java 2007). Even though Twitter is a "noisy" space and the length of messages is limited, Honeycutt and Herring (2009) argue that very informal scientific collaborations can still flourish. These lightweight interactions are critical to SciCity's role as an 'electronic network of practice' (Wasko and Faraj 2013) wherein practice-based knowledge is regularly exchanged between members primarily via Twitter and other social media.

Mentorship

Mentorship occurs when "an experienced person provides guidance and support in a variety of ways to the developing novice [...], being a role model, [and acting] as a guide, tutor, or coach, and a confidante" (Bolton 1980). Mentorship can be either professional or personal and can have cognitive and affective

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effects on both mentors and mentees (Murthy, Rodriguez and Kinstler 2013). The cognitive effects of the relationship include professional development, job efficacy, and career focus within the mentee. The affective side of mentorship can often be instrumental in determining a mentee's job attachment, confidence, and overall satisfaction with their professional choices (Burke 1984; Zimmerman 2002). Active mentorship can help develop active and confident professional leaders (Burke 1984) and can encourage a mentor's performance to improve as their protégée can provide technical skills and enthusiasm to increase a mentor's productivity (Burke 1984; Wright 1987).

Social media and social networking technologies potentially have utility in connecting would-be mentors and mentees and could bridge traditional barriers such as time and location. Three key types of online mentorship have been identified in the literature: (1) "CMC-only" whereby computer-mediated-communication (CMC) occurs when mentors and mentees interact solely online; (2) "CMC-primary" occurs when the majority of mentoring interactions occur online; and (3) "CMC-supplemental" occurs when the majority of communication occurs face-to-face with online tools acting as a supplement (Ensher 2003). Though CMC can play various roles in facilitating mentorship, Ensher (2003) also highlights the potential risks associated with mentorship that can occur online such as miscommunication and breaks of confidentiality (Ensher 2003).

Communication between two individuals over new media can form either "strong" or "weak" ties (Haythornthwaite 2002). Weak ties include superficial, often peripheral relationships in which individuals rarely exchange information or personal details in the frequency of interaction is usually low. Strong ties contain, "...a higher level of intimacy, more self-disclosure, emotional as well as instrumental

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exchanges, reciprocity in exchanges, and more frequent interaction” (Haythornthwaite 2002). This frequency of interaction between strong ties is generally higher than in weak ties and the mentor and mentee share substantive, often personal information. The low time cost of social media facilitates the formation and maintenance of a multitude of weak ties with a wide variety of people. These ties can expose one to new networks of ideas and opportunities (Haythornthwaite 2002). Mentoring relationships themselves can be classified as either regular (structured) or irregular (sporadic). Regular mentorships have a high frequency of contact in which the mentor and mentee meet on a regular schedule. In irregular mentorships, mentors and mentees interact more sporadically.

Whether they are strong or weak, social media can facilitate interpersonal ties and can lay the groundwork for the formation of mentoring relationships. Because of its often sporadic, ‘always-on’ nature (Hermida 2010), Twitter may be conducive to the formation of weak, irregular mentoring relationships or informal relationships that organically emerge around particular topics of practice. Because of Twitter’s stream of updates, the medium enables users to be aware of others in their network (Hermida 2010). Twitter can be particularly effective in quickly connecting geographically dispersed people and activating lightweight and latent connections (Hermida 2010). These weak, latent ties have the potential to develop into sporadic online mentoring relationships (Liu 2012).

RESEARCH QUESTIONS

1. Does social media aid in the formation of both cognitive- and affect-based trust within a scientific community?

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2. Can meaningful scientific collaboration occur solely through social media or are face-to-face interactions also needed to solidify cognitive and affective trust?
3. Are social media able to facilitate meaningful forms of mentorship?

METHODS

Respondents from SciCity were recruited both online and offline through four non-random sampling methods. The first cohort of respondents was recruited from survey research we previously conducted on SciCity (Author A). The final question of this survey contained a request for volunteers to participate in a brief Skype-based interview. Using common SciCity hashtags, members were also recruited over Twitter. To protect respondents' anonymity, no participant was singled out and asked to participate directly in the research via publicly accessible social media (i.e. @mention on Twitter). Additionally, respondents were recruited in person at a SciCity social event in New York City. Lastly, using snowball sampling methods (Goodman 2011; Sadler 2010), recruited respondents were also asked to recommend several of their fellow SciCity community members who might be interested in participating in this research. Snowball sampling yielded additional respondents. Following Saunders' (2012) advice on the difficulties of recruiting organizational respondents, we employed these mixed recruitment methods to maximize the size and diversity of our respondents.

We conducted 11 interviews over the summer of 2012. They were semi-structured interviews, which varied in length, from 15-45 minutes. Interviewers relied on a preset script, but were free to ask follow-up and clarifying questions. These semi-structured interviews explored respondents' backgrounds,

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involvement and engagement in the SciCity community, Twitter usage, and interactions with SciCity via Twitter including their use of Twitter to live tweet during face-to-face events (see Table 1). Respondents who did not use Twitter (or did not use Twitter to engage with the SciCity community) were asked to elaborate on their non-Twitter based-relationship with SciCity members and on their use of social media sites in general.

Interview Topic	Sample Questions
Background Information	<p data-bbox="727 873 1027 905">Age, gender, occupation.</p> <hr/> <p data-bbox="727 951 1247 982">Do you use social media? If so, which sites?</p>
Relationship to SciCity Community	<p data-bbox="727 1035 1170 1066">How did you first hear about SciCity?</p> <hr/> <p data-bbox="727 1108 1230 1171">How often do you engage with the SciCity community?</p> <hr/> <p data-bbox="727 1213 1312 1276">How do you engage with the SciCity community? Twitter, Facebook, community events?</p> <hr/> <p data-bbox="727 1318 1170 1381">Do you generally feel welcome in the community?</p> <hr/> <p data-bbox="727 1423 1317 1486">When you engage with the SciCity community do you gain valuable information?</p>
Relationship to Individual SciCity Members	<p data-bbox="727 1541 1279 1604">Can you describe the relationships (if any) you have formed with SciCity members?</p> <hr/> <p data-bbox="727 1646 1230 1709">How often do you seek advice from fellow members?</p> <hr/> <p data-bbox="727 1751 1214 1814">Have you ever collaborated with a fellow member?</p> <hr/> <p data-bbox="727 1856 1187 1887">Have you ever engaged in a mentoring</p>

	relationship either as mentor or mentee in the SciCity community?
SciCity on Twitter	Do you connect with the SciCity community on Twitter? <hr/> Do you use #SciCity? <hr/> Do you think it is possible to create relationships with the SciCity members you have met on Twitter? <hr/> Have you ever met up face-to-face with someone you initially met on Twitter? <hr/> What role do you think Twitter plays in the SciCity community?
SciCity Events	Have you ever attended a SciCity event? <hr/> What was your first SciCity event like? <hr/> Do you tweet during events? <hr/> If you are unable to attend an event do you still follow along via the Twitter stream?

Table 1 : Interview Topics and Sample Questions

As the members of SciCity are generally busy professionals, we chose to conduct interviews by Skype. While most respondents appeared comfortable using Skype, several participants opted out of video chat, and asked for a traditional phone-based interview instead. To ensure the anonymity of our respondents, all names were changed. Additionally, any identifying information – such as Twitter ID, age, or location – was also withheld.

Data coding

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NVivo, a CAQDAS (Computer Assisted Qualitative Data Analysis) software package (Schönfelder 2011), was used to organize interview data in a structured format. We utilized 10 NVivo codes: Trust, Collaboration, Mentorship, Absence of Trust, Absence of Collaboration, Absence of Mentorship, SciCity Community, Twitter, Other Social Media, and Demographics. Our trust codes were developed from Lewicki (2006) and use a range from high to low. We utilized two different methods to explore the perceived presence and absence of trust. The first model, is based on Jarvenpaa's and Leidner's (1999) model of swift trust and, following McAllister (1995), we adapted an alternative indication of trust along an affective and cognitive scale to explore the perceived presence or absence of these attributes (see Figure 1).

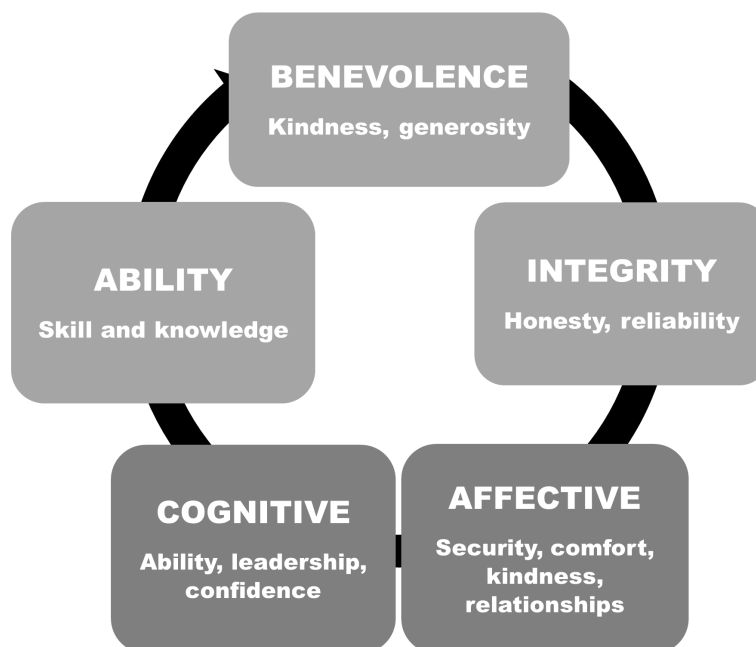


Figure 1: Trust model

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We coded for formal collaboration, which included instances where collaboration occurred within a structure that has institutional or official approval (e.g. on a paper, developing a protocol, or organizing an event). Informal collaboration included instances in which individuals had worked together sharing ideas informally either face-to-face or online. Short-term collaboration was classified as lasting less than a year and long-term collaboration was classified as lasting a year or more (see Figure 2). The perceived absence of collaboration, however, was coded using a different set of variables designed to probe the reasons why a collaborative relationship was felt to be absent. Competitiveness, disagreement between collaborators, and lack of confidence in the co-collaborator (in terms of ability and or integrity), were all seen as factors that might impact why someone would not collaborate (Widmark 2011). Those three categories, along with lack of familiarity and lack of homophily (Cummings 2008) were placed as sub-codes under the absence of collaboration.

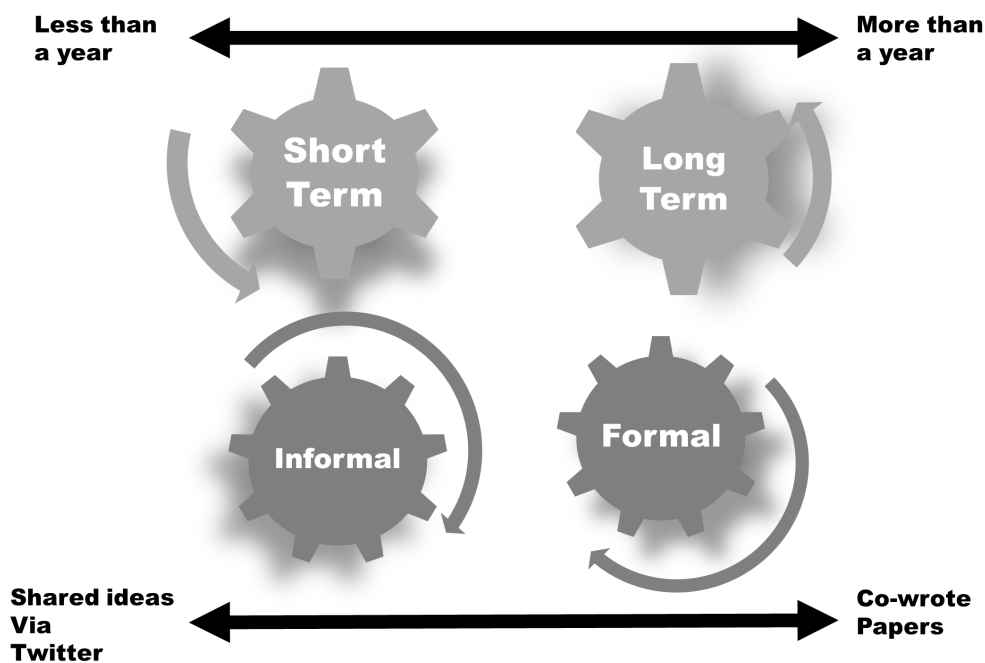


Figure 2: Collaboration Model

We defined mentorship as the continued exchange of information between two people in an uneven power differential for the purposes of career development. We defined the mentor as the individual who gives information and support, and the mentee as the individual that receives information and support. As we were interested in the impacts of having a mentor, we divided the effects of having mentorship into cognitive-based and affect-based following Zimmerman (2002). The mentorship code was subdivided to classify mentorship as being career based, where “topics relate to the advancement of a scientific career” (Author A 2012) or personally-based, which warranted the “disclosure of personal information” and caused the mentee to seek advice in personal matters (Author A 2012). Figure 3

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visually represents our mentorship model. Our sub-codes also denoted the method of communication for the mentorship, and whether it occurred online, or face-to-face. The absence of mentorship was categorized similarly. The cognitive impact of lacking a mentor, which entailed a negative effect on professional and academic development (Zimmerman 2002) was recorded as was the affective impact of lacking a mentor, which resulted in lower levels of professional attachment and efficacy and less focus on one's success. With this framework, we were also able to evaluate whether any perceived absence/presence of mentorship was more associated with Twitter or SciCity meet-up interactions (or a combination thereof).

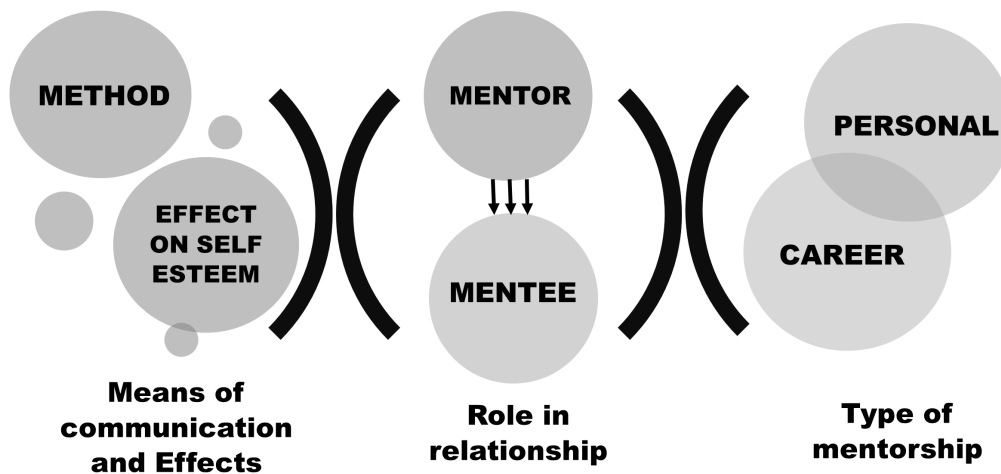
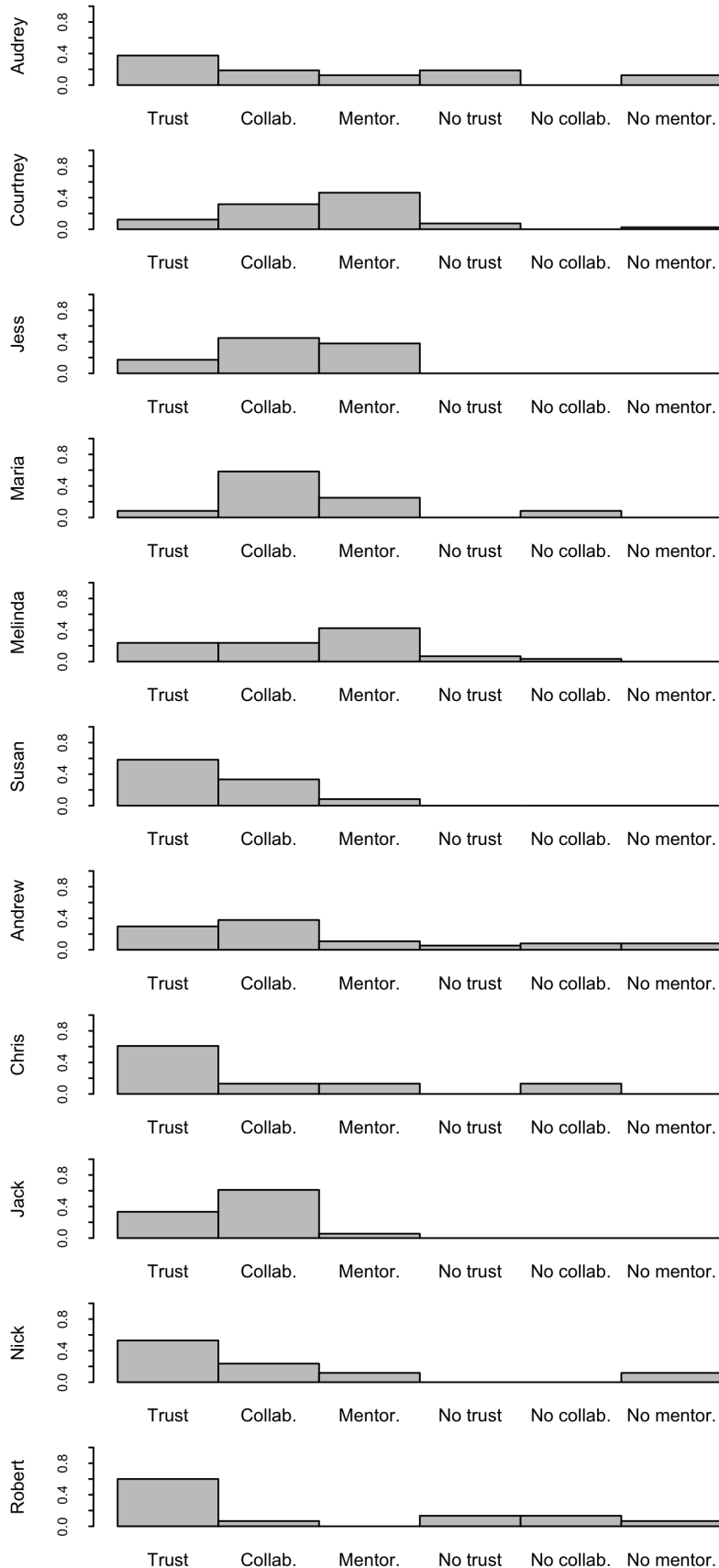


Figure 3: Mentorship Model

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RESULTS

9% of the SciCity population was interviewed, a substantial response rate given the busy schedules of these life scientists. 54.5% of respondents were female and 45.5% were male. As Figure 4 illustrates, negative scores of collaboration, trust, and mentorship were very low, affirming that respondents generally perceive SciCity positively.



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Figure 4: Frequency of codes per user as a percentage

Trust

We first explored whether social media aids in the formation of both cognitive- and affect-based trust within SciCity. We found that social media serves as an important tool for simultaneously enhancing both cognitive- and affect-based trust in SciCity. Though trust varies in the SciCity community, Twitter is seen by respondents as an important part of maintaining trust amongst SciCity members.

The respondents interviewed in SciCity displayed high levels of both cognitive and affective trust. The high levels of cognitive trust suggest that members believe in the ability of others within the SciCity community, while the high level of affective trust in SciCity indicates that members open up to each other emotionally. Twitter provides an easy way for members to regularly interact with, thereby maintaining a vibrant community. Synchronous interaction can help facilitate trust (Iacono and Weisband 1997) and the synchronicity of tweets, retweets, and direct messages is no exception. We also found that SciCity supports Iacono's and Weisband's (1997) argument that synchronous interactions can be displays of trust in themselves. Cognitive and affective trust enables respondents to relay technical information, while the high level of affective trust in SciCity indicates that members open up to each other emotionally.

SciCity members repeatedly cited Twitter as a facilitator of cognitive-based trust within their community. The perceived constancy of information flow on Twitter creates a conduit for trust, whereby members see incremental displays of ability, which, when aggregated, are part of an overall perceived

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ability. In other words, these trust-based interactions are developed over time from micro-interactions. For example, one of our respondents, Chris, met a fellow SciCity member who followed a similar professional circle on Twitter. They exchanged direct messages and tweeted with each other regularly. Chris describes how he relies on her professional advice, stating, “so I basically take her advice on...what sort of microscope field strength would be ok, so what sort of power would be good to shoot particular samples, or if you’re looking to buy a new microscope...what are the things you should look at”. Though the quality and depth of their interactions were augmented face-to-face, Twitter connected them and remains their primary means of communication. These Twitter interactions have encouraged Chris to interact with this microscopist beyond the physical SciCity events. Similarly, Jack details seeking advice from other SciCity members. He states, “[another member] gives me some advice cause [...] he does stuff that is a little different than what I do [and] helped me on an article I was writing”. Jack, a daily Twitter user who frequently uses the medium to stay in contact with the SciCity community, has sought advice from the group, identifying certain individuals as supportive because their expertise extends into areas he is inexperienced in. Similarly, Nick describes how he looks to SciCity for professional guidance because “lots of people there are really good at what they do, and what they do is different from what I do and I would certainly trust them in that area”. Community members increase their trust of fellow members via Twitter-based interactions (which display ‘ability’).

Even those SciCity members who do not actively seek advice from community members still expressed high sentiments of cognitive-based trust. Indeed, one SciCity member, who is neither an active Twitter user nor a frequent and engaged attendee of events, still described her belief in SciCity’s overall capacity to provide credible knowledge and skills. When asked if she would turn to the SciCity community seeing

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advice or guidance on an issue, either professional or personal, Audrey states, “yeah...I mean there’s a lot of people there that probably don’t know me but that I um you know follow on Twitter and [...] I definitely respect their opinions and think that they have some great ideas”. Despite the fact that she has never sought support from SciCity, she indicates that she values their ideas and opinions enough to identify SciCity as a potential source for cognitive support. Twitter is influential in structuring this cognitive trust as Audrey’s main interactions with SciCity are via Twitter and not face-to-face. Similarly, Andrew describes how he attended SciCity solely on the basis of a SciCity member on Twitter whom he followed. Melinda describes her fellow SciCity members’ professional knowledge positively, noting that many of them are experts in their fields. She sees Twitter as an extension of SciCity’s face-to-face events and as an important venue through which to achieve the organization’s goals. These cases exemplify how, within SciCity, Twitter can establish and create a perception of trust, even with a limited amount of substantive communication.

Our respondents indicated that SciCity fosters high levels of affect-based trust. We hypothesized that social media plays a role in facilitating affect-based trust within SciCity by enabling members to regularly interact outside of face-to-face events. Twitter was perceived to help SciCity members seek out other members within their community and establish a rapport. The regular exchange of casual social tweets can incrementally build affect-based trust. We found that like cognitive-based trust within SciCity, affect-based trust can form and be maintained on Twitter. Unsurprisingly, the degree of trust and whether it is reciprocated varies case by case. Within SciCity, Twitter is particularly good for maintaining affect-based trust across a diverse audience, because it creates the perception of ‘constant’ connectivity.

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Evidence of affect-based trust among SciCity members appeared in displays of benevolence to fellow members. For example, Susan explains how Maria, an organizer, has stayed at her home, saying, “she actually stayed in our apartment a couple times when she’s in town, and needs some place to crash” and Andrew, who is engaged to Susan, notes “I’ve become pretty good friends with Maria since I met her at SciCity”. Susan and Andrew have clearly developed affect-based trust with Maria. The extent of their benevolence indicates that SciCity can be an incubator for deeper, closer ties and connections. This affect-based trust, which was first conceived on Twitter, transitioned to face-to-face interactions as well.

Social media’s ability to synchronously update helps foster these relationships. For example, Chris, notes, “we [SciCity members] tweet at each other, we’re Facebook friends, so I guess, we comment on each others’ baby pictures and things like [...] I know what some of them ate for breakfast, we are friends now”. The social updates gleaned from social media allow fellow members (followers or friends, depending on the social media platform) a ‘backstage’ (Goffman 1967) peek into members’ lives. By regularly interacting through comments, tweets, or retweets, users are able to develop a certain level of intimacy. Interestingly, Chris indicates that he does not socialize with SciCity members outside of face-to-face SciCity events. However, his comment about other members’ baby photos on Facebook contradicts this, affirming that some social networking is indeed social, but the interactions are so lightweight that they are not explicitly perceived as part of sociability.

Furthermore, respondents indicated that Twitter can be instrumental in kick starting relationships. For example, Melinda notes that there was a SciCity member “from Twitter that was coming to New York on

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a business trip and [I] reach[ed] out to a couple of lady friends and we all got together and it was really great [...], some stuff has happened in the flesh but [...] most of the stuff that happens tends to be on Twitter or via email". Melinda had recently moved to New York and used the SciCity Twitter community to make friends and professional acquaintances. SciCity's Twitter space provided an easy means to connect with like-minded scientific professionals. Melinda's Twitter interactions highlight the medium's role in building social vitality and having an accessible means of communication that extends beyond SciCity's face-to-face events.

Jack emphasizes the importance of SciCity to him, stating, "[SciCity] really enriched my life, I've gotten to meet a lot of interesting people and [...] I've made friends through it so that I think that's a very good form of support". Jack's comments demonstrate a high level of affective trust and its concomitant emotional support. Jack explicitly recognizes Twitter's role in creating and developing a relationship, mentioning his own experiences of this. Tweets can present a glimpse of what a user finds interesting and allows similar users to connect and potentially build relationships. Similar to Jack, Nick observes how SciCity acts as a non-traditional science space, noting "there's definitely people [...] outside of the regular science focused events [...], definitely people I consider my friends show up" online and offline.

Ultimately, our respondents indicated that Twitter serves an important role in maintaining affect-based trust. Melinda, sees Twitter as a way to maintain relationships in SciCity, stating "We're still following each other on Twitter [...] I don't think we've gone to dinner or anything [again, but ...] occasionally we dm [direct message]". Melinda illustrates how Twitter can provide an easy and effective way to maintain weak ties within a professional organization. Twitter interactions can also breed a level of familiarity,

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which kick starts relationships at face-to-face events. For example, Susan observes, “there are a lot of people I had only seen on Twitter. I only knew them from their picture on Twitter and kind of what they’d been tweeting about, and then you kind of meet them in person and it’s always kind of, uh, a funny moment. But it’s a good feeling too”. Andrew states, “there were a lot of people I hadn’t met before but that I had seen online in some capacity so it was really great to meet them and speak face to face and you know just set up those sort of connections that you don’t often get the opportunity to do”. Andrew’s and Susan’s experiences illustrate how Twitter-based interactions can breed familiarity so that when they met in person at SciCity events, they already had a basis of familiarity and potentially trust, as established by Twitter.

Collaboration

Formal collaborations in SciCity include members collaborating/writing research papers, submitting grants, and organizing events including workshops and symposia. The collaboration is task-oriented and generally results in a tangible finished product. Though formal collaborations do occur in SciCity, the organization more often incubates non-traditional forms of collaboration. Specifically, SciCity members see ‘collaboration’ as spanning a spectrum from information sharing to more traditional formal collaboration. Respondents usually related examples such as collaborative blog posts or organizing meet-ups. Some respondents saw Twitter interactions with fellow SciCity members as forms of collaboration (what is discussed below as ‘lightweight’ collaboration). Other respondents did not perceive their Twitter interactions as collaborative. However, their descriptions of how they use Twitter include sharing resources, posting discussion points relevant to recent community topics, and staying in

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touch with fellow SciCity members between events - all actions that could be considered as potentially fostering collaboration. It is likely that the ubiquitous nature of Twitter led our respondents to perceive their interactions on social media as merely social, rather than social and collaborative. The sharing of ideas and opinions is a staple of SciCity interactions on Twitter.

Lightweight Collaboration

Many of the SciCity interactions on Twitter include 'lightweight' collaboration, which includes sharing links, informal brainstorming, and locating potential collaborators. Jess highlights an instance in which she shared detailed resources with a fellow SciCity member on Twitter about the Bayh Dole act (an intellectual property law), prompting tweets from other members. In this example, SciCity members shared ideas and resources on Twitter. They engaged in lightweight collaboration to produce a guide to navigating intellectual property law on publicly funded research projects. Jess explains that Twitter draws people into the SciCity community through "the domino effect where someone responds to something I've written and then someone responds to them and there's all these sub conversations happening that I don't even see until later on". Though he himself does not identify it as collaboration, Jack actively comments and retweets within SciCity's Twitter space. Chris sees Twitter as an ideas sound box, stating "I get to sound off a lot of my ideas about science articles [... with] SciCity members I follow on Twitter and who follow me on Twitter". Through the SciCity Twitter network, Chris is able to get feedback on his ideas, an important mode of lightweight collaboration.

While a few respondents maintained that collaboration does occur via Twitter alone, this was an exception and those respondents struggled to provide concrete examples of collaboration. For example,

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Melinda states, “I can’t give you concrete examples right now but I have heard of some of my Twitter professor friends who um have either established collaborations or they send each other papers for review if they’re in the same field”. There is a belief that SciCity-related collaboration is taking place on Twitter, but few respondents are able to provide specific examples (e.g. Andrew and Melinda). One explanation for this is that the regularity of informal collaborations on SciCity’s Twitter space overshadows single instances. An alternative explanation is that the collaborations are particularly weak (e.g. link sharing or early stage brainstorming).

For some respondents, Twitter is an effective medium to share links, and generate topical discussion due to a critical mass of shared interest amongst SciCity members. Andrew states, “if I notice something that would be of interest [...] I will bring up that question and I do tag it with SciCity”. Jack sees #SciCity as having a high level of homophily stating, “I start following them [on Twitter] and see that [...] I write about very similar things for different audiences”. For Chris, a shared connection over Twitter introduced him to the SciCity community itself: “I basically got to know of SciCity through Twitter [...as] I followed a person who was interested in [... topics] I tweet about”. Chris believes that Twitter promoted connections well beyond the life sciences, exposing him to a range of scientists across the disciplines.

Respondents felt that the SciCity Twitter space broke down geographical barriers, a known inhibitor to the formation of collaborative relationships (Cummings 2008). Twitter has been found to foster telepresence between geographically displaced people (Hutchins 2010) and, in the case of SciCity, Twitter facilitates proximity in two ways. First, it promotes intra-member dialogue between face-to-face events by creating a venue for discourse that is not dependent on space or even time (though

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synchronicity vastly impacts the intensity of lightweight collaboration on Twitter). Second, Twitter promotes a feeling of proximity during SciCity events because of its use as a ‘backchannel’ stream of communication. Since backchannels can break down the speaker-audience paradigm (Reinhardt 2009), they can also increase opportunities to communicate. Maria, who is often unable to attend events because she does not live in New York City, actively tweets during #SciCity events. Jess, who attends every event, explains how #SciCity has included global participation, stating that because SciCity is “bringing down all these geographical barriers, people are chiming in from Australia [...], England from [, ... and] from all over the world because of the Twitter stream”. Robert, another regular attendee, agrees, adding “I had a conversation with two people on Twitter during the last SciCity and it actually turned out that they were not in the room with me. They were like in England. Yeah and that sort of totally shocked me because I had assumed that everyone who was on that Twitter was in the room but that wasn’t the case”. Thus not only can Twitter connect geographically displaced SciCity members between events but it can also allow members unable to attend events the opportunity to participate in the discussion. The implications of this are that while the community is targeted to science professionals in New York, respondents see Twitter as helping construct a community not constrained by geography.

By increasing the level and frequency of contact between SciCity members, Twitter aids in the formation of a collaborative space by fostering ‘familiarity’ (Cummings 2008). Through retweeting and the persistent use of shared hashtags, SciCity community members who are active on Twitter are regularly engaging in incremental community building, which can lay the foundation for collaboration. Nick believes that Twitter is the best medium to get in contact with other members, stating, “it’s really easy to reach people on Twitter if I wanted to contact someone about something. If I contacted them on Twitter

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I found that it gets me a reply very very quickly. Whereas if I tried to email them or go through some other means it would take much longer". The low time cost of tweets (less than 140 characters) is seen to trigger faster responses and this increased level of contact, in turn, creates a space that is more conducive to knowledge sharing within SciCity.

Formal Collaboration

We found that Twitter alone is generally unable to facilitate formal collaborative relationships. Maria clearly explains, "I think Twitter on its own in most times is not enough to let you actually collaborate on full-on projects". Multiple respondents highlight the challenges of collaborating via Twitter. For example, Jack states "if I'm gonna collaborate on Twitter I really would need to meet [...] the person offline or just through e-mail or something like that". Jack feels that Twitter interactions are not sufficient to collaborate. Andrew adds that while collaboration is, "possible, it's not as [pause] how should I put it [pause] face-smacking you know. It doesn't strike you in quite the same way as when you're actually there face-to-face". Referring to the experience of participating in SciCity events virtually, Andrew feels that Twitter-based interactions are likely to lack a wow factor. For him, they do not facilitate the same level of intensity as face-to-face interactions as SciCity events.

Although Twitter alone is not generally able to facilitate formal collaboration, Twitter is seen by respondents to play an important role in the collaborative process. Maria describes Twitter's role in bringing people together in non-Twitter based spaces by stating: "It's [Twitter] just a very useful tool for kind of raising awareness for things I guess...The actual friendships, in terms of the behind the scenes, planning [...] or putting together a project, that sort of thing, that's taking place in person or by email... I

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wouldn't say that's (collaboration) solely through Twitter, people will be talking on Google hangout, people will be Skypeing each other, or people will be, you know, sending drafts of things backwards and forwards by e-mail". Andrew agrees, adding that he prefers to move potentially collaborative relationships formed on Twitter onto other media, stating "once people start wanting to organize something maybe they send me a direct message and I say hey let's do this over email cause that's a good medium for that". In these cases, Twitter can be seen as an important collaboration kick starter for SciCity members to create deeper connections.

Irregular(sporadic) – Undirected Mentorship

Irregular, undirected mentorship occurs when a mentee seeks guidance sporadically from a community or network rather than from a specific individual. Many SciCity members seek irregular, undirected forms of mentorship. Because SciCity members are relatively accessible on Twitter, the medium has the potential to be the first source in which to solicit mentorship advice. Twitter was seen by respondents as a potential mentorship space where mentoring ties might be latent, but can be activated if a good mentoring opportunity presents itself.

Maria believes that Twitter can be useful for the formation of mentoring relationships on SciCity, stating "I think Twitter has the ability, depending on how people will use it, to give you an extra layer of context about people's lives. So, for example, if somebody tweets very actively things like hey, I've just finished my PhD, hey I'm looking for a job now, hey I really want to move to [Washington] DC and get a job [..., then] you're much more peripherally aware of that [as the #SciCity hashtag has a] sense of constant background chatter and updating". By creating a "broad, asynchronous, lightweight and always-on

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communication system” (Hermida 2010) full of the “constant background chatter” Maria refers to, Twitter was able to foster on-the-fly mentorship in SciCity.

Respondents describe instances where they found that the SciCity Twitter network met their mentorship needs. For example, Chris feels that there is a back and forth on SciCity’s Twitter where members are seeking advice and guidance. Audrey believes that Twitter can foster the process of asking and answering questions, stating “There are some conversations like people throw out some questions and people invariably answer back”. In this way, lightweight mentorship can occur (e.g. should I apply for this grant?). Other studies on online forums (Author A, 2013) found that the process of asking and answering questions is not only important to virtual community building, but also to mentorship. However, instead of seeking out advice from a specific SciCity member, the mentorship knowledge of the whole community is collectively targeted through Twitter, much like the ways in which forums and listservs operate. As mentorship is structured between an individual and the organization, individual mentorship ties themselves remain weak.

Irregular (sporadic)-Direct Mentorship

Unlike irregular undirected mentorship, irregular direct mentorship occurs when individuals seek out the advice of specific mentors. Usually, these mentorships occur offline between SciCity members who have interacted with one another face-to-face. Much of the mentorship is done by four of the most active SciCity members - Jess, Maria, Nick, and Andrew - who are highly visible on #SciCity and at monthly events. Because of the ‘leadership’ role they play in SciCity, they are sought out for their mentorship. Jess unabashedly states, “I don’t want to like toot my own horn or anything but a lot of people do

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approach me and ask me to read things over or to hash things out or to have a conversation about some of their ideas and I think a lot of people do look towards me". Maria plays a similar role in SciCity and describes her experiences acting as a mentor "I have helped people [...] who have been looking for jobs [and] when I've seen jobs that were kind of suited for them, I've forwarded them the links that I've seen". By actively providing direct guidance to individuals, Jess and Maria operate as mentors within the traditional mentor-mentee relationship. Moreover, Jess and Maria see themselves as hubs for irregular direct mentorship within SciCity, but the lack of specific mentees demonstrates the weak ties inherent to such mentorship.

SciCity's organization is not structured to promote regular mentorship and there is no system of pairing up mentors and mentees as can be found in many mentoring programs (Ensher 2003). Since event attendance and Twitter activity is highly variable, it would be challenging to meet virtually or face-to-face with a mentor on a consistent and regular basis. An additional explanation for why accounts of strong regular mentorship were absent from our interviews might have to do with the private nature of regular mentorships in SciCity. As Andrew points out, "[a] mentorship is sort of like a friendship. You don't go around screaming I'm friends with this person and you're meeting right now". It is possible that there is strong mentorship within SciCity, but respondents were not forthcoming with examples because of the intimate nature of mentorship relationships within the community. Even though respondents did not describe instances of regular collaboration, many did seek mentorship opportunities within SciCity. Courtney, for example, hopes that SciCity might help her grow her mentorship network. She states, "I'm definitely in need of expanding my mentoring network" and views SciCity as a vehicle to do this. Chris agrees that SciCity is a 'great place' for mentorship possibilities.

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Additional evidence of the SciCity community's enthusiasm for mentorship can be seen in a recent community blog discussion series about experiences with science mentors. The blog often hosts discussions about event topics prior to the events themselves and for many members is a way to continue SciCity discussions before and after events. The discussion series on mentorship asked bloggers to submit their personal experiences with mentorship. Among the 14 blog posts, members discussed academic mentors such as professors and senior science community members, along with friends and family. One blogger, however, spoke to online mentorship in particular, describing how online mentorship can connect junior and senior science professionals from all around the world.

CONCLUSIONS

Twitter and other social media are usually not thought of as fostering scientific collaboration. However, in the case of SciCity, a life science community of practice, Twitter has not only emerged as an integral part of the organization, but respondents see Twitter as building trust and promoting collaboration and mentoring relationships. The medium is also seen as playing a vital role in maintaining the vibrancy of the SciCity community. Contrary to recent findings (e.g. Lovejoy, Waters and Saxton 2012) and because of the demographics of SciCity (relatively young and tech savvy), respondents feel that Twitter is an ideal method of organizational communication. Since tweets are rapid as well as simultaneously widespread and direct, the medium provides multiple methods to effectively activate latent ties within SciCity which can be harnessed for collaboration or mentorship.

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Additionally, SciCity is seen by many respondents as an ‘electronic network of practice’ (Wasko and Faraj 2013) wherein practice-based knowledge is regularly exchanged between members electronically rather than needing to attend SciCity events or even live in New York. Respondents see the regular lightweight knowledge sharing and mutual engagement on Twitter and other social media as critical to maintaining SciCity’s role as a network of practice. However, we found that more active SciCity members who have attended at least one meet-up were most involved in collaborations and serving as mentors. What emerges is an organizational center that remains New York City-based and participates regularly in meet-ups and an electronic network of practice supported by both the center and a geographically diffuse periphery. This structure is fluid as SciCity members who are not regularly active can become central figures if the practice-based topic being discussed in social media is within their particular expertise.

We found that trust, collaboration and mentorship are operating within SciCity, but that Twitter is not exclusively responsible. Rather, trust, collaboration and mentorship are born out of the combined effects of SciCity’s Twitter based communication face-to-face events. However, Twitter was seen by respondents as playing an instrumental role in building both cognitive- and affect- based trust within SciCity. Because Twitter hosts a synchronous stream of information, respondents saw the medium as a conduit to display ability (a precursor for cognitive-based trust). This cognitive trust allows SciCity Twitter users to turn to each other professionally.

Often times, this cognitive trust online serves as a social lubricant when SciCity Twitter users met face-to-face. Twitter was felt to play an important structuring role in this relationship formation, particularly

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because it introduces new members to seasoned members and to the community as a whole. Twitter also plays a role in building affect-based trust between SciCity members by promoting familiarity and social interaction through low-cost (time and effort) tweets. Twitter was found to foster affect-based trust between individuals outside of face-to-face events by maintaining continued contact after an initial meeting face-to-face. As Dunlap and Lownethal argue (2012), Twitter also provides a means to enhance social presence through the 'exchange of quick, frequent answers' in which real-time 'microsharing' facilitates perceived social presence. In the case of SciCity, respondents saw Twitter as fostering social presence both between physical meet-ups as well as amongst the larger community that do not attend these meet-ups. Questions are asked and quickly answered and knowledge is easily produced and widely consumed within the SciCity Twitter network.

We found that collaboration within SciCity is situated on a spectrum from lightweight to heavyweight collaboration. Twitter was found to facilitate lightweight collaboration between SciCity members online , but was not necessarily a conduit for heavyweight collaboration. Rather, respondents indicated that in order to form heavier, formal collaborative relationships between members, non-Twitter-based communication (usually over email or face-to-face) was necessary. While the limited 140-character availability within tweets could potentially hinder deeper collaborative connections, Twitter might still provide an impetus for further collaboration outside the platform.

We also found evidence that there are two types of mentorship occurring within SciCity: directed irregular mentorship and undirected, irregular mentorship. Directed irregular mentorship is centered on

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the most active members. Because of their central and highly visible position within SciCity, potential mentees often felt comfortable directing mentorship requests to these hubs. Indirect, irregular mentorship occurs primarily on Twitter. Because of Twitter's ability to create networks of weak and latent connections in which users can sporadically engage, the medium was seen as an ideal platform for promoting these types of mentorship relationships. Specifically, the SciCity Twitter network serves as what Hermida (2010) refers to as an 'ambient awareness system' whereby members become active if they have expertise or an interest in a tweet. Respondents see Twitter as an accessible, low-effort space. Because the organization's goals are not focused on promoting regular mentorships, regular (structured) mentorships do not usually exist within SciCity (though some respondents feel that they might be kept private). Respondents also felt that Twitter was an important venue for recruitment. Some respondents noted how they became involved with SciCity via Twitter and that if SciCity relied on e-mail and Facebook alone, there would be little opportunity for SciCity to maintain its organizational diversity. Gender may also play a role in terms of collaboration and mentorship in virtual scientific organizations. While male respondents produced a large proportion of codes for trust, female respondents were more heavily coded for mentorship and collaboration. Our study is focused on a small set of respondents and is unable to generalize on gender. However, our work points to the need for further research that explores whether these types of virtual work are gendered.

Ultimately, SciCity provides an interesting case study in that it is not exclusively virtual, but also involves regular meet-ups. This offline component was felt to be critical by respondents for developing mentorship and collaboration. Twitter was seen more as a kick starter for the forms of mentorship and collaboration that took place over e-mail, Skype, or face-to-face. That being said, respondents found

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that tweets were valuable for lightweight forms of mentorship and collaboration, such as asking for advice about a particular job, relevant journal articles to resolve a problem, or to identify potential collaborators. This utility of Twitter as a kick starter should not be overshadowed by the fact that it is not associated by respondents as a venue for more formal mentorship and collaboration. Rather, the medium itself is inherently bound by 140 character tweets, which are not always an ideal conduit for supporting the nuanced complexity of collaboration and mentorship. However, an important finding is that Twitter was found to serve as a 'social lubricant' (Leonardi and Meyer 2014), making contact easier and faster and helping foster a scientific social network. Though minor in its role in specifically fostering scientific collaboration, the use of social media by SciCity indicates a small shift towards acceptable uses of social media for scientific organizations.

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