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A Metric to Assess Brokerage Positions within Social Networking Sites

by Martin Rehm, Frank Cornelissen, Ad Notten & Alan J. Daly - 2020

Background/Context: Teachers and educational professionals can draw on (informal) networks to foster their professional development. Moreover, a growing number of studies have shown that teachers use social networking sites (SNSs), such as Twitter, to keep up to date with the latest news on education and share resources with colleagues. Additionally, social capital can help to explain potential benefits of networking and has already been used to better understand professional development.

Purpose/Objective/Research Question/Focus of Study: The aim of this study is to contribute to a better understanding of the informal networking of educators in SNSs. To achieve this goal, we first indicate how the concept of social capital can be used to assess communication flows within SNSs. Then, we consider social networking metrics and question whether they are as relevant in an online realm. Next, we argue for an adjusted brokerage index, namely the social brokerage index (SBI), which can help to shed light on how brokerage positions are shaped by different people within SNSs. Finally, we provide empirical data from six educational hashtag conversations on Twitter to test the relevance and applicability of the SBI.

Research Design: Using Twitter data from six (international) hashtag conversations between teachers and educational professionals, we apply social network analysis methods to assess the potential formation of social capital. In applying this method to the Twitter conversations in question, we first collected data on the Twitter users who contributed to the applicable hashtag conversation. Subsequently, we built directed unweighted one-mode networks based on mentions, and replies matrices. Second, we computed the in-degree, out-degree, and overall degree centrality metrics of all users (nodes) taking part in the applicable hashtag discussions. Additionally, we also determined users' brokerage positions, which is another indicator for social capital formation within networks. Questioning the relevance of these metrics in the context of SNSs, we propose the SBI, which departs from previous work that has largely been framed by considerations around general account characteristics (follower/following ratio), general communication patterns (retweet/mention ratio), or in-degree metrics.

Conclusions/Recommendations: Based on our findings, we believe that our proposed SBI has added value to the analyses of network behavior beyond the scope of Twitter. More specifically, the SBI could help to understand what type of discussions draw what type of participants and thereby shed more light on how SNSs contribute to social capital formation among teachers and educational professionals.

SOCIAL NETWORKING SITES: A PLACE TO (INFORMALLY) NETWORK

The importance of training and development as a pivotal aspect in contributing to the competitive advantage of organizations has been highlighted by numerous scholars (e.g., Argote & Ingram, 2000; Nonaka, 1994). More specifically, in today's turbulent (economic) environment, employers and employees constantly need to update their knowledge and skills in order to face new challenges (Chalmers & Keown, 2006). Similarly, in educational science, which will be the focal domain of this study, an increasing need to develop and implement new, collaborative approaches to educational practice has been identified (Finsterwald et al., 2013). Moreover, Hokka and Etelapelto (2013) suggested that the continuous professional development of teachers is a pivotal element in the provision of high-quality education. However, teachers and educational professionals do not have to rely solely on formal support roles and institutions. Instead, they can draw on (informal) networks wherein they can share their ideas and collaboratively reflect on their practice (Fox & Wilson, 2015). Research suggests that professional development, learning, and change often occur through social interactions in such networks and depend on social relationships to provide access to other people's resources, such as knowledge, abilities, and skills (e.g., Borgatti & Foster, 2003; Bourdieu, 1986; Coleman, 1988). Even more so, Hattie (2013) found that teacher-driven activities, such as often occur in collaborative networks, tend to be more effective than top-down interventions, which are imposed by more formal professional development actors. One example of such an activity is Edcamps (e.g., Carpenter, 2016), which are increasingly popular among teachers and essentially constitute an "unconference" (Wake & Mills, 2014, p. 1025). There is no predetermined agenda; only the time frame is set. The content is determined in grassroots fashion, where all participants can make suggestions and organize their own sessions around a certain topic. The other participants then "vote with their feet" and attend the sessions they consider interesting. Hofman and Dijkstra (2010) proposed that these types of (informal) networks can provide teachers with a platform to engage in collaborative communication processes, exchanging insights and ideas, which contributes to their professional development. Furthermore, scholars have postulated that the potential advantage of informal networks lies in their possibility to provide teachers with a platform to continuously engage in collaborative activities and (informal) networking (e.g., Butler & Schnellert, 2012; Hopkins, 2000).

Nowadays, the rise of social networking sites (SNSs) has led to a panoply of online communication spaces, wherein individuals can communicate with one another and that lend themselves to engagement in collaborative communication processes. A recent study on the Twitter discussion around the implementation of Common Core standards in the United States has provided valuable contributions to our understanding of how information is shared and distributed within SNSs (Supovitz et al., 2015). Moreover, a growing number of studies have shown that teachers use SNSs, such as Twitter, to keep up to date on the latest education news and share resources with colleagues (Risser, 2013). These types of findings provide empirical support for more theoretical considerations by scholars such as Marotzki (2004), who saw an unprecedented opportunity for social media to connect people with differing backgrounds, thereby enabling them to exchange information and learn from each other's (practical) experiences. SNSs essentially provide informal spaces wherein individuals can engage in their professional development (Spanhel, 2010). In contrast to formal spaces, the focus here is not

primarily on the acquisition and transfer of knowledge (Marotzki & Jörissen, 2008). Instead, individuals are enabled to contextualize their knowledge and experience by having access to a plurality of others' (different) opinions and experiences (Tynjälä, 2012). The aim of this study is to contribute to a better understanding of educators' informal networking using SNSs. To achieve this goal, we first indicate how the concept of social capital can be used to assess communication flows within SNSs. Then, we consider social networking metrics and question whether they are as relevant in an online realm as they are in an offline setting, where individuals are in direct contact within a physical location. Next, we argue for an adjusted brokerage index, namely the social brokerage index (SBI), which can help to shed light on how brokerage positions are shaped by different people within SNSs. Finally, we provide empirical data from six educational hashtag conversations on Twitter to test the relevance and applicability of the SBI.

SOCIAL CAPITAL IN SOCIAL NETWORKING SITES: THE EXAMPLE OF TWITTER

Tsai and Goshal (1998) defined social capital as “relational resources embedded in the cross-cutting personal ties” that “are useful for the personal development of individuals” (p. 464). Based on this definition, it has been widely acknowledged that this theoretical concept can contribute to our understanding of how informal networks develop and evolve over time (e.g., Moolenaar et al., 2012; Risser, 2013). Additionally, social capital can help to explain potential benefits from networking (e.g., Fox & Wilson, 2015) and has already been used to better understand professional development (e.g., Baker-Doyle & Yoon, 2011). Social capital allows us to capture the value of informal networks “as a resource that teachers can draw upon to improve their teaching” (Hofman & Dijkstra, 2010, p. 1032). Furthermore, Nahapiet and Ghoshal (1998) distinguished between three dimensions of social capital, namely, a *structural*, a *cognitive*, and a *relational* dimension. The structural dimension is concerned with the social interactions between individuals within a particular setting, such as a social networking site. The cognitive dimension deals with the question of whether participating actors share a common understanding and terminology. Finally, the relational dimension of social capital describes issues such as trust and common values among individuals. In the context of this study, we focused on the structural dimension of social capital and examined informal networks on Twitter to better understand the development of social capital in SNSs.

Twitter is a lightweight tool for easy communication that enables individuals to share information about any topic in so-called tweets that are limited to 140 characters. Twitter also allows communication with other users, for example, via *direct messages*, *mentions* (e.g., @user), *replies* (e.g., RT @user), or *hashtags* (e.g., #topic). Including hashtags in tweets has become common practice on Twitter and allows individuals to include their contributions in a larger conversation about a certain topic, which enhances their opportunities to access networks and further develop their already existing ones (G et al., 2010). Yet, in contrast to other SNSs, such as Facebook or LinkedIn, the main goal of Twitter has not been to act as a community-building platform (e.g., Gruzd et al., 2011). Instead, it has greatly contributed to the ease and flexibility with which information can be shared among large groups of people, irrespective of time and place (Ye et al., 2012). One central aspect that fosters this process is the underlying structure of Twitter, which features a persistent conversational log where all messages are saved on a user's profile page. Consequently, with the exception of private messages and accounts, all contributions to the Twittersphere are searchable and can be accessed by others (Isari et al., 2016). However, Twitter has evolved into more than merely an information exchange portal; “examples of extended conversations . . . show that some users are already taking advantage of Twitter for informal collaborative purposes” (Honeycutt & Herring, 2009, p. 9). Hence, boyd and colleagues (2010) concluded that spreading information—for example, via mentions or replies—is not merely sharing information, but also engaging with others and reflecting on one's own practice. Moreover, a growing amount of research has investigated Twitter as a platform for community building and development (e.g., Gruzd et al., 2011; Isari et al., 2016; Jussila et al., 2013; Takahashi et al., 2015). Additionally, according to Jussila and colleagues (2013), the resulting communication flows are subject to individuals taking on different roles within a conversation. More specifically, whereas some individuals might have an advantage in collecting (new) information, others might be better able to aggregate the information, provide direction, or organize discussions. In itself, this provides an almost natural link to social capital considerations, because they foster the development of relationships and connect people (Ahn, 2012). The development and involvement of social capital within SNSs in general has already been the subject of previous research (e.g., Fox & Wilson, 2015; Hofer & Aubert, 2013; Ranieri et al., 2012; Steinfield et al., 2008; Yoon, 2014). The underlying notion is that SNSs such as Twitter can increase individuals' social capital by enabling them to connect with new people and maintain relationships across geographical regions (e.g., Ye et al., 2012). Furthermore, network concepts such as centrality and brokerage belong to the most commonly used metrics to assess and determine social capital within network structures (e.g., Moolenaar et al., 2012). The concept of centrality is concerned with the structure of a network and an important measure of how connected an individual (node) is with others (alters) (e.g., Freeman et al., 1979). Furthermore, degree centrality is an easy way to capture how often an individual has been contacted (in-degree) and how often that same individual has contacted others (out-degree) (e.g., Abbasi et al., 2012). Brokerage can be said to build on these concepts because it is concerned with gaps in network structures, also referred to as structural holes (Burt, 2009), and how individuals can close these gaps and potentially benefit from connecting otherwise disconnected individuals or groups of people (e.g., Gould & Fernandez, 1989).

Yet, despite the general awareness that informal networking and social capital formation play an ever-growing role in individuals' professional development, research on this topic within SNSs remains underresearched (e.g., Aramo-Immonen et al., 2016), and previous research can be critically examined on the basis of five main issues. First, the specific role of social capital within the context of informal networking remains uncertain (e.g., boyd & Ellison, 2007; Panzarasa et al., 2009). Moreover, prior research remains ambiguous regarding the process of social capital formation. Some scholars have argued that SNSs provide individuals with equal access to social capital formation (e.g., N. Lin, 1999); others proposed that some individuals and groups will be able to control communication processes and thereby attain higher levels of social capital than others (e.g., Bourdieu, 1986). Although the results of recent studies on SNSs suggest a biased communication process, as suggested by Bourdieu (e.g., Lefebvre et al., 2016; Macià & García, 2016; Riquelme & González-Cantergiani, 2016; Van Waes et al., 2016b), the ambiguity continues to dominate academic discussion about the topic. Second, previous research has largely been based on student populations. Although the applicable results have greatly contributed to our understanding of how communication processes are shaped and develop over time within SNSs, they only have limited relevance for the context of professional development among working professionals, such as teachers (e.g., Eraut, 2004). Third, teachers have largely been neglected in the analysis of informal networking and social capital formation within SNSs. Consequently, a number of authors (e.g., Kukulska-Hulme, 2007; Owen et al., 2016) have called for more research on how teachers use social media and how it can contribute to their professional development. Fourth, previous studies have often used social network

analysis (SNA) to assess and determine social capital formation within SNSs. In this process, *centrality* (e.g., Freeman et al., 1979) and *brokerage positions* (e.g., Burt, 2009) are common network metrics used to describe underlying structures. This approach provides valuable insights into how networks are influenced by individuals. However, we surmise that it works better in an offline context, where the only chance to really access an individual's knowledge and expertise is via direct contact. For example, if Person A talks to Person B about a certain topic in a physical location (e.g., a room), and Person C is not in their vicinity or within hearing distance, there is hardly any chance for Person C to know what has been talked about without asking Person A, Person B, or both. On the contrary, in an online social opportunity space, where the vast amount of communication is publicly available, this rather clear-cut distinction does not seem to fully capture the essence of the underlying communication process (e.g., Daly et al., 2013). If Person A writes a public tweet to Person B, Person C or any other person who might be interested as a matter of course can now easily see what type of information has been exchanged. The present study addresses these shortcomings by investigating whether conversations on Twitter have the potential to contribute to social capital formation among teachers and education professionals. Furthermore, we propose a new metric that can contribute to a better understanding of how social capital formation takes place within SNSs. Departing from a social capital perspective and building on the aforementioned considerations and perceived gaps in prior research, we formulate two main research questions: (1) To what extent are individuals able to attain a central position within a Twitter hashtag network? (2) In what way can the communication processes within SNSs be captured from a social capital perspective with a new metric?

DATA

Twitter is a lightweight tool for easy communication that enables individuals to share information about any topic. Messages are labeled "tweets" and are generally limited to 140 characters. Moreover, individuals can communicate with others via direct messages (which are private), mentions (e.g., @user), replies to (e.g., RT @user), or hashtags (e.g., #topic). This type of communication has greatly contributed to the ease and flexibility with which information can be shared among large groups of people, irrespective of time and place (Ye et al., 2012). Including hashtags in tweets has become common practice on Twitter and allows individuals to include their contributions in a larger conversation about a certain topic. This not only enhances their ability to access networks but also allows individuals to further develop their existing ones (Letierce et al., 2010). In the context of this study, we will focus on six educational Twitter hashtags: #acps, #caedchat, #edchat, #ntchat, #nyedchat, and #satchat. These indicated hashtags were chosen based on three main underlying considerations. The first was the number of participants and the perceived popularity of the chat. For this purpose, we considered the growing number of teacher portals and blogs (e.g., Edutopia, Education Week, Edublogger, and International Society for Technology in Education), which offer guides and recommendations for teachers and other educational professionals on how to engage in discussion on Twitter, as well as which conversations are "worth their time." Second, we did not want to narrowly focus on one specific content domain within education. Instead, we were interested in investigating our research questions and proposed a new metric across different topics—in that sense, also differing target groups (e.g., #ntchat: new teachers; #satchat: school leaders). Third, we were interested in studying Twitter conversations with different scopes and geographical outreach. Hence, we chose a fairly local chat among teachers of a particular school district (#acps), and we included statewide initiatives (e.g., #caedchat) and discussions that drew a global audience (e.g., #edchat). Table 1 provides a summary of the topics discussed in the individual hashtag conversations.

Table 1. Overview of Hashtag Conversations

Hashtag	Topic
acps	Used by Abemarle County (Virginia) public school teachers to foster informal exchange of ideas and teachers' professional development
caedchat	Mainly focusses on the state of California and originates from an Edcamp
edchat	Weekly conversation among U.S. teachers, which has grown into a global exchange on teaching trends and educational technology
ntchat	U.S.-based initiative that targets preservice teachers and other educational professionals who are new to the field
nyedchat	Initiated by and targeted toward teachers from the New York area
satchat	Weekly Twitter chat for current and emerging school leaders; nominated for the 2015 BAM Education Award

Although these types of Twitter conversations have different target audiences, they all have a similar underlying pattern. Participants can generally vote on one of a few possible topics to discuss and are actively incorporated into the planning of upcoming conversations. Once a topic has been chosen and determined, organizers, usually two, then structure the conversation by posting, on average, eight guiding questions. These questions are then tweeted about chronologically by all participants. Additionally, most organizers also facilitate the conversation by retweeting selected contributions or connecting ideas and experiences from different individuals. However, the latter aspect is highly dependent on the size of the participating group and the number of contributions submitted. Moreover, #edchat constitutes an exception from this general pattern; it has evolved into a continuous discussion without predetermined time frames. To provide exemplary cases for mentions and replies to in this particular context, we share two examples from the #edchat conversation.

@useraccount: It is helpful for #teachers to agree with students what can be called stepped/variable performance #goals #planning #edch? (Mention)

@useraccount that's fantastic! We appreciate the support and welcome all teachers to contribute ideas. Enjoy! #engchat #edchat #usmfac (Reply to)

Using the software tool NodeXL, the data were collected over a one-month period, from March 18 through April 18, 2016. The collected data were then imported into the R and Pajek software packages to conduct social network analyses (SNAs). We note at this stage that the collection of data from social media has raised questions of ethical concern among the research community. More specifically, some scholars are concerned about the confidentiality of information gathered from human subjects, as well as the public confidence and trust in researchers' work (e.g., Koene et al., 2015). While acknowledging the importance of these types of concerns, we are proponents of the work from, among others, Moreno and colleagues (2013), who defined a human subject as "a living individual about whom an investigator obtains data through interaction with the individual or identifiable private information" (p. 709). Based on this definition, they argued that data from social media, particularly Twitter, qualify as an exemption from strict ethical guidelines and considerations. Participants generally use these types of platforms to publicly disseminate their thoughts, ideas, and experiences. Consequently, as in our case, if researchers only collect publicly available data from social media, which can be obtained without a password, concerns about confidentiality and trust can be relaxed.

METHOD

This study revolves around the question of whether social capital is built within SNSs among teachers. In this context, we are particularly interested in the connections between individuals. Using Twitter data from six (international) conversations between teachers and educational professionals, we apply SNA methods to assess the potential formation of social capital (e.g., Nahapiet & Ghoshal, 1998). At this point, we would like to acknowledge the growing number of twitterbots (Edwards et al., 2014), socialbots (Boshmaf et al., 2011), and cyborgs (Chu et al., 2010) on Twitter. Each term describes (semi-)automated software programs and tools that mimic human tweets with sometimes questionable motives, such as phishing schemes and distributing malware (Zhang & Paxson, 2011). Although this has become a growing concern among scholars conducting research on Twitter data, socialbots and cyborgs have been identified mostly in areas involving certain topics and themes, including geopolitical developments, such as the Arab Spring (e.g., Khondker, 2011), and topics often related to business and marketing (e.g., Kaplan & Haenlein, 2010). Consequently, we believe that they have only a very limited impact on our data set and the resulting research findings.

SOCIAL NETWORK ANALYSIS

SNA has been widely acknowledged as a valuable tool to assess social capital (e.g., Moolenaar et al., 2012; Rienties et al., 2013; Tsai & Ghoshal, 1998). In applying this method to the Twitter conversations in question, we first collected data on the Twitter users who have contributed to the applicable hashtag conversation (Bruns & Stieglitz, 2013). Subsequently, we built directed unweighted one-mode networks based on mentions and replies matrices. We decided to omit tweets because this type of contribution does not connect the sender with anyone else. Instead, it is a regular message that goes out to the entire world. Second, we computed the in-degree, out-degree, and overall degree centrality metrics of all users (nodes) taking part in the applicable hashtag discussions. These metrics provide an indication of how often an individual has been contacted or has contacted others. Additionally, we also determined users' brokerage positions (e.g., Burt, 2009), which is another indicator for social capital formation within networks (Rehm & Notten, 2016). To determine individuals' brokerage positions, we followed the work of Gould and Fernandez (1989) and other scholars such as De Nooy and colleagues (2011), who distinguished between coordinator, itinerant broker, representative, gatekeeper, and liaison. How these roles translate into actual network positions is highlighted in Figure 1 (based on De Nooy et al., 2011); here we see that the brokerage concept depends on triadic relationships.

Figure 1. Possible brokerage roles for an individual within a network

In the case of the coordinator or itinerant broker role, an individual mediates between otherwise disconnected parties that belong to the same group—the decisive difference being that the coordinator belongs to the same group as the others, whereas the itinerant broker is an external party that connects otherwise disconnected individuals from within the same group. A practical example of a coordinator is a superintendent (Figure 1, v) who obtains information from one principal in her area (Figure 1, u) and then moves that information to another principal in the area (Figure 1, w). Hence, information stays within one school district but is brokered between otherwise disconnected principals via an external party. In the case of an itinerant broker, the superintendent of School Area B (Figure 1, v) might be informed about a certain new classroom management tool by the principal from School Area A (Figure 1, u). She then communicates this to another principal from School Area A (Figure 1, w) who has not yet been in contact with her colleague from within her school area. A representative acts as the "face of the group" and is responsible for channeling information to members of other groups. In practice, this could be a superintendent (Figure 1, v) who receives a piece of information from a principal in her area (Figure 1, u) and then shares this with the superintendent of another school area (Figure 1, w). Similarly, the gatekeeper also represents the group. However, in this particular instance, she is in charge of the incoming information to the group. Hence, in this case, a superintendent (Figure 1, v) would receive information from the superintendent of another school area (Figure 1, u) and then share it with the principal of her own area (Figure 1, w). Finally, individuals who take on the role of liaison act as an intermediary between otherwise disconnected parties from different groups. Here, one superintendent (Figure 1, v) may be informed about a certain development by the superintendent of another school area (Figure 1, u) and then channel this information through to another

superintendent (Figure 1, w) who has not yet heard about it. The applicable metrics are determined by calculating the “number of incomplete triads in which this [individual] plays the corresponding brokerage role” (De Nooy et al., 2011, p. 153).¹

Proposing a Metric for Social Networking Sites: Social Brokerage Index

These metrics are commonly used to assess and determine social capital within network structures (e.g., Moolenaar et al., 2012). However, as indicated earlier, we consider that they work better in an offline context, where individuals are in direct contact within a physical location. For example, in the scenario described earlier for the itinerant broker, the superintendent of School Area B (Figure 1, v) will have to directly contact the principal from School Area A (Figure 1, w) to share the information from School Area B’s principal (Figure 1, u). In an online realm, such as online SNSs, this distinctive feature is getting blurred (Daly et al., 2013). Here, Principal B might have been in contact with the superintendent via a publicly available SNS (e.g., Twitter) to share information that Principal A could then immediately see. Consequently, A and B are no longer dependent on the principal to actively forward the information through her information network. Yet, central positions within networks are usually associated with advantageous positions for receiving and/or disseminating resources and information (e.g., Ibarra & Andrews, 1993; Sparrowe et al., 2001). Moreover, they are identified by having high-degree centralities (Scott, 2017). However, if Principal B mentions something to the superintendent via a tweet, anyone who might be interested can easily gain access to the same information and potentially benefit from it. Therefore, central actors are no longer required for one to gain access to valued resources (pieces of information). Instead, it becomes increasingly important how an individual shapes their role (Jussila et al., 2013). Consequently, overall degree metrics might not necessarily capture what is going on within SNSs because they do not allow for a distinction between in-degree (receiving) and out-degree (disseminating) connections. Additionally, it is not so much about attaining a brokerage position; instead, how an individual shapes their role becomes increasingly important (e.g., active vs. passive). In this context, Smith and colleagues (2014), as well as Rainie (2014), have been able to identify six types of (Twitter) conversations that support this notion. Hence, although centrality measures and brokerage positions are still very relevant and useful to apply to social network analysis in online settings, we believe that these metrics can be modified to better represent the “new” circumstances and contribute to our understanding of how communication networks develop and evolve online. Moreover, one can wonder whether the concept of periphery also might have to be revisited. Periphery still correctly refers to a situation whereby an individual is not “actively” part of a discussion, but the individual can still observe and be a passive part of the discussion. Furthermore, considering the permeability of online and offline opportunity spaces, one can even think of situations in which an individual passively collects information from one space and transfers it into another space, where that person is then a key player.

Yet, despite the general agreement that determining centrality and brokerage positions within networks is an important aspect of understanding how they form and what type of information is shared and distributed (e.g., Borgatti & Cross, 2003; Casciaro, 1998; Johnson-Cramer et al., 2007), identifying these types of network members may prove more difficult than expected (e.g., Boster et al., 2011). Another aspect that adds to this challenge in the case of Twitter is the platform’s “directed friendship model” (Marwick & boyd, 2010, p. 116), which does not require connections to be reciprocated. For example, Barack Obama (@BarackObama) has 76.5 million followers who read the messages (tweets) that are distributed from his account. On August 8, 2016, between 6:00 a.m. and noon, he was mentioned 15,742 times and replied to 1,396 times—while his account tweeted zero messages. Consequently, a regular network centrality measure would put him into a central position within the network, indicating that his account would broker information between approximately 30 subcommunities of at least 10 users. In SNA terms, this account would be described as a hub (e.g., Himelboim et al., 2013). We consider that to be a heavily biased representation of the accounts role. Although it certainly is an important account that acts as a broker between a wide range of different others, it does not (and cannot) actively pursue this role. Instead, it passively contributes to the general exchange of information between like-minded, as well as opposing, individuals.

To account for these considerations, we build on previous work on this topic (e.g., Anger & Kittl, 2011; Gould & Fernandez, 1989; Kleinberg, 1999; Panzarasa et al., 2009; Tremayne, 2014) and propose an SBI; this departs from previous work that has largely been framed by considerations around general account characteristics (follower/following ratio), general communication patterns (retweet/mention ratio), or in-degree metrics. Instead, we devised our metric by first normalizing the degree difference and then rescaling this metric on a scale from -1 (*very passive*) to +1 (*very active*), where the underlying formula can be represented as²:

$$diff_i^{Degree} = (diff_{max}^{Degree} - diff_{min}^{Degree}) * \frac{degree_i - degree_{min}}{degree_{max} - degree_{min}} + diff_{min}^{Degree}$$

Additionally, we determined four subcategories within the measure’s scale, which were based on the underlying quartiles and represent: (1) *very passive* ($-1 \leq x < -0.5$), (2) *mostly passive* ($-0.5 \leq x < 0$), (3) *mostly active* ($0 \leq x < 0.5$), and (4) *very active* ($0.5 \leq x \leq 1$). Those categories were then labeled as (1) *social hub*, (2) *social authority*, (3) *social organizer*, (4) *social influencer*. Social hubs (1) are mentioned and contacted by a large amount of others, who “name-drop” them in their contributions without necessarily expecting a reply from them. As illustration, Barack Obama is commonly included in a wide range educational discussions on Twitter (e.g., Common Core, No Child Left Behind). However, the account’s input has been very limited, although it acts as a “common denominator” that other accounts seem to use to identify themselves with the underlying ideology and mindset. On the other hand, it is also widely used among Obama’s opponents, who would like to distance themselves from his political agenda. It therefore acts as a hub, where a wide range of information, views, and experiences is shared without the account actively contributing itself. A social authority (2) is similar to a social hub; this type of account is also often included in others’ messages as a way to name-drop. Others would like to users to know that they are dealing with a similar topic and that they have something interesting to say. However, social authorities are also recognized by the Twittersphere as accounts that regularly share (valuable) information about a variety of conversations, while also taking the time to engage in discussions and mention and reply to others. In the context of education, those accounts are often dedicated websites for teachers (e.g., Edutopia) and teachers who have won awards (e.g., Global Teacher Prize) or are officially certified innovators (e.g., Google-certified teacher). By using the terminology of hub and authority, we build on the work of previous research, which has predominantly been conducted in the context of website rankings (PageRank), based on *hypertext-induced topic selection* (e.g., Amento et al., 2000; Bharat & Henzinger, 1998; Ding et al., 2002). We agree that the applicable algorithms and metrics can be very useful in the context of our line of research. However, we argue that the underlying rationale is

not well suited to describing active behavior among participants of a Twitter chat. Consequently, we use the terminology for the passive spectrum of our proposed metric.

The term “social organizer” (3) describes an account that actively represents the user’s opinions and views. This account shares information with others by directly mentioning them in a tweet and engages in discussions by replying to others’ contributions. In the context of education, the owners are perceived to be knowledgeable by others; this manifests itself as invitations to speak at face-to-face events, such as workshops and Edcamps. It is also likely that these accounts regularly organize and facilitate live Twitter conversations. Finally, social influencers (4) have a lot in common with social organizers. However, they are even more active in participating in a range of different Twitter conversations, and they tend to win awards for outstanding performance and often have their own dedicated webspace (e.g., a blog) where they post their thoughts, observations, and opinions. Moreover, a preinvestigation showed that not only do they tend to organize and facilitate a Twitter chat, but members of this group will also be the founders of these types of chats. Describing actors in network spaces as influencers or brokers also builds on previous research in this area. More specifically, some scholars refer to the concept of *opinion leaders* (Del Fresno García et al., 2016a, p. 25). This term describes individuals who have an impact on the views, opinions, and perceptions of others (e.g., Burt et al., 1998). Yet, as in our previous example about Barack Obama on Twitter, we believe that being influential does not necessarily equate to being active in a discussion or actively pursuing a brokerage role. Others have chosen, for example, Barack Obama to be the broker to another domain. Therefore, we believe that our metric is better able to capture the active engagement of being a broker, which would translate into degree difference and therefore being categorized into SBI 4 (social influencer). Consequently, we will use our proposed SBI on the collected data from the six Twitter hashtag conversations to determine whether individual accounts have actively pursued their brokerage position (SBI 3 and 4), or whether they have been name-dropped into the conversation to enhance the potential reach of a Twitter message (SBI 1 and 2).

RESULTS

RESULTS FOR THE REGULAR NETWORK METRICS

Table 2 provides an overview of the main characteristics of the different hashtag conversations. As can be seen, there is some variability between the hashtag conversations in terms of activity and in the number of participants joining the hashtag conversation in the applicable time frame. However, some general trends can be seen across the hashtags.

Table 2. Overview of Main Results (per Hashtag)

Hashtag	# of Users	Mentions				Replies			
		In-Degree		Out-Degree		In-Degree		Out-Degree	
		M	SD	M	SD	M	SD	M	SD
acps	934	2.63	11.21	2.63	14.22	0.13	0.66	0.13	0.86
caedchat	2,116	2.08	8.22	2.08	4.50	0.23	1.34	0.23	1.90
edchat	25,609	2.21	35.06	2.21	27.28	0.03	0.39	0.03	0.55
ntchat	533	1.15	7.51	1.15	1.85	0.00	0.04	0.00	0.04
nyedchat	979	2.52	10.96	2.52	9.71	0.26	1.53	0.26	4.77
satchat	4,497	1.63	12.03	1.63	3.65	0.01	0.14	0.01	0.15

First, there is a considerable standard deviation from the mean in both types of contributions: mentions and replies. Second, mentions are more commonly used than replies. To put these metrics into perspective, Figure 2 provides some exemplary sociograms from four of the six hashtag conversations to shed more light on what the network structures looked like.

(a) #ntchat (Mentions)

(b) #nyedchat (Mentions)

Figure 2. Exemplary sociograms of the underlying network structures

Note. Layout: multidimensional scaling; size of nodes: overall degree centrality; shading of nodes: Louvain clustering algorithm.

As can be seen, there is again noticeable variability between the different networks. However, there also are some common characteristics. First, the mentions networks (Figure 2a and 2b) have contributed to a set of interconnected nodes (giant component) that are in contact with each other. However, there were also groups of isolate nodes and smaller subclusters that communicated with each other but did not actively join the larger discussion. This latter observation is particularly prominent in case of the replies networks (Figures 2c and 2d). These networks were sparsely connected, yet the nodes that were connected regularly replied to each other and really did seem to engage in a discussion about the topics relevant to that particular hashtag chat (as highlighted by the increased size of the nodes).

Turning to the brokerage positions across the different hashtags, Figure 3 provides a graphical summary of the results for mentions and replies, respectively. The brokerage positions have been identified on the basis of relevant adjacency matrix and the Louvain clustering algorithm (Blondel et al., 2008). As can be seen from Figure 3, with the exception of #ntchat and #satchat, the coordinator, representative, and gatekeeper seem to be the most commonly represented types of brokering positions across the hashtags (mentions, Figure 3a). The perceived picture changes when considering the replies networks (Figure 3b). Here, brokerage positions are considerably less prominent, with the exception of #nyedchat. These are already interesting findings and help to categorize different hashtag conversations into different types of discussions. Moreover, attaining brokerage positions has been associated with acquiring social capital (Burt, 1997, 2009; Rehm & Notten, 2016). However, as indicated earlier, we have some reservations about whether this analysis provides a representative picture of what actually happens during the hashtag conversations. Consequently, we ran another set of analyses to test our proposed metric and to assess whether it could indeed provide added value by taking into account the level of passive and active behavior among actors in SNS communication, such as on Twitter.

Figure 3. Brokerage positions per hashtag

Mentions

Replies

RESULTS FOR THE NEW NETWORK METRIC: SOCIAL BROKERAGE INDEX

Figure 3 provides an overview of how the normalized degree difference, the first step toward the SBI, is distributed across the different hashtags. Considering the mentions networks, with the exception of #acps, all hashtag conversations are centered on zero, indicating that the majority of participants in these conversations had balanced communication behavior. They were sharing information with others as much as information was shared with them. The situation was somewhat different in case of the replies networks. Here, there was a tendency for hashtag conversations to show a positive trend, meaning that participants replied more to other people than were replied to. Another aspect that Figure 4 highlights is the considerable variability within the individual hashtag conversations.

Figure 4. Distribution of normalized degree difference across hashtags

Social hub (Role 1): When comparing this particular role between the mentions and replies networks, it is apparent that it is somewhat more pronounced only in the #caedchat and #nyedchat hashtag conversations. The other hashtag conversations have members in either the mentions network or the replies network. **Social authority (Role 2):** This role exhibits a high degree of variability in both networks. Moreover, there seems to be a slight tendency to move toward zero, indicating more balanced communication behavior. For #caedchat, #edchat, and #ntchat, the distribution in the replies network has less variance, suggesting that the participants showed more comparable types of communication behavior. **Social organizer (Role 3):** This role essentially mirrors the social authority but in the positive spectrum. There is a general trend toward zero, and the mentions network exhibits more variance than the replies network. **Social influencer (Role 4):** This role has a pattern comparable with that of the social hub. With the exception of #edchat, participants' behavior qualified them for this role in either the mentions or the replies network. The variance within the category is considerably less than for Roles 2 and 3.

Figure 5 combines our social brokerage metric with the regular brokerage roles (De Nooy et al., 2011; Gould & Fernandez, 1989). As can be seen, our metric differentiates between the active (SBI Categories 3 and 4) and passive (SBI Categories 1 and 2) regular brokerage role types. More specifically, when considering the mentions network, we are able to show that the coordinator, gatekeeper, and representative (in decreasing order), who are normally perceived to have active roles, are in fact predominantly passive, composed of representatives from the social hub and social authority SBI categories (SBI 1 and 2). Hence, these people have been "chosen" by others to take on this role and did not necessarily strive to be in this position. In the replies network, the story is reversed. Here, the social organizers and social influencers, who are the active categories in our metric, really do take over the regular brokerage positions. Interestingly, to a lesser extent, this also holds true for members of the second category (social authorities), whose behavior we defined as mostly passive.

Figure 5. Brokerage positions per social brokerage index

Mentions

Replies

CONCLUSION

This study set out to investigate whether hashtag conversations on Twitter contribute to social capital formation among teachers and educational professionals. More specifically, departing from social capital theory (e.g., Baker-Doyle & Yoon, 2011; Fox & Wilson, 2015; Nahapiet & Ghoshal, 1998; Tsai & Ghoshal, 1998), we collected data from six (international) Twitter conversations. These conversations were all founded in the United States, with some drawing a steadily increasing crowd of global followers. The foci of the Twitter conversations range from discussions among new teachers (#ntchat), to school districts (#acps) and states (#caedchat and #nyedchat). However, they also constitute platforms for school leaders to exchange information (#satchat) and for teachers and educational professionals to share information on, for example, new media in education or how to motivate 10th graders (#edchat).

Our investigation was based on SNA, which is widely acknowledged as a valuable tool to assess social capital (e.g., Moolenaar et al., 2012; Rienties et al., 2013; Tsai & Ghoshal, 1998). We computed the in-degree, out-degree, and overall degree centrality metrics of all applicable users, and we provided an indication of how often an individual had been contacted or contacted others. We also determined users' brokerage positions (e.g., Burt, 2009), which is another indicator for social capital formation within networks (e.g., Rehm & Notten, 2016). While these metrics are commonly used in these types of analyses, we critiqued their usage within the context of SNSs. Based on the underlying structure and affordances of SNSs, they do not necessarily capture the essence of the underlying communication patterns (Daly et al., 2013). Consequently, we proposed a new metric: the social brokerage index. We then used this metric to identify four different roles that an individual could take within SNS conversations. More specifically, we suggested that SNS discussions and the resulting networks were (in part) influenced by (1) social hubs, (2) social authorities, (3) social organizers, and (4) social influencers.

Overall, the results of this study can be considered as providing preliminary insights into the potential of Twitter to contribute to teachers' formation of social capital. Participants shared information, got connected, and thereby contributed to their own social capital and that of others. Moreover, a closer look at the sociograms revealed that social capital formation took on different forms within the two types of investigated networks. The mentions networks were subject to larger groups of people connecting, sharing information, and staying in contact. In contrast, the replies networks were more characterized by smaller groups of participants staying in closer contact, seemingly engaging in what could be described as a joint discussion about topics of concern. Another indication for the formation of social capital was discovered when considering the brokerage positions of the individual participants (Rehm & Notten, 2016). Here, three roles were particularly prominent: coordinator, representative, and gatekeeper. Interestingly, being categorized into one of these three roles meant that the person had already created some rapport with at least one of the other people with whom they connected. We are therefore able to second the conceptualizations and empirical findings of other scholars, who have identified social capital as a useful concept to explain the potential benefits that teachers can accrue from networking (e.g., Fox & Wilson, 2015), and some scholars have already used the concept to help understand teachers' professional development (e.g., Baker-Doyle & Yoon, 2011).

The described findings directly contributed to the assessment of our first research question, which was concerned with the extent to which individuals were able to attain a central position within their Twitter conversations (RQ1). Our sociograms revealed that some people gravitated toward the center of their respective networks. Even more so, these individuals were also the ones who were able to attain the highest scores for the brokerage positions. These findings are in line with previous research that has stipulated that some individuals are prone to attain more central positions within networks and potentially impose limits on other individuals' opportunity to gain increased social capital (e.g., Bourdieu, 1986). Yet, we could also distinguish between two types of central positions within the overall network. More specifically, while some individuals attained central positions in both types of networks (mentions and replies), some users were also central in either the mentions network or the replies network. However, this did not necessarily show in the results of the brokerage positions.

Hence, we considered this to be support for our criticism of the regularly used SNA metrics in SNS research and considered in what way communication processes within SNSs can be captured from a social capital perspective with a new metric (RQ2). Commonly used network metrics provide valuable insights into how networks are influenced by individuals. However, they are based on scenarios in which individuals can meet face-to-face and do not necessarily fit the underlying communication patterns within an online social opportunity space (e.g., Daly et al., 2013). As a result, we proposed the SBI, which comprises four roles: (1) social hub, (2) social authority, (3) social organizer, and (4) social influencer. Applying this metric to the networks at hand revealed that we were able to zoom in on, and provide a more fine-tuned measure to distinguish between, active and passive brokerage positions. More specifically, our Categories 1 (social hub) and 4 (social influencer) can contribute to unscrambling whether a certain brokerage role was actively pursued by an individual or that person was chosen to fulfill this task.

Consequently, based on our findings, we believe that our proposed SBI has added value to the analysis of network behavior beyond the scope of Twitter. It can also help to shed light on how brokerage positions are shaped by different people in other SNSs, such as Facebook or LinkedIn. This in turn would provide valuable insights on how communication processes develop and evolve over time in these types of networks. It would also allow for the profiling of SNS conversations. More specifically, the SBI could help us to understand what types of discussions draw which types of participants. Is a certain SNS conversation subject to a group of social influencers who might be trying to steer conversations and possibly influence the content of what is being shared? Is a particular information exchange centered on social authorities, who act as a "common denominator" around which a wide range of information, views, and experiences is shared? How are the different roles distributed among participants of an SNS conversation? Do participants give and take, or is their activity level skewed toward a more passive or active type of behavior? We believe that our SBI can contribute to answering these types of questions and shed more light on how SNSs contribute to social capital formation among teachers and educational professionals.

LIMITATIONS AND FUTURE RESEARCH

This study, although rich in descriptive and analytical data, exhibits four main limitations that can provide valuable input for future research in this field. First, the analyses were based on a short time frame. Future research should conduct more prolonged longitudinal analyses. Second, the current data are based on user statistics from Twitter. Although this objectified approach has acknowledged benefits (e.g., Hofer & Aubert, 2013), it also is subject to some concerns regarding the data that can be harvested from Twitter (e.g., Ruths & Pfeffer, 2014). Consequently, although it can be argued that the impact of the data sets at hand is limited, one needs to be careful in drawing conclusions when trying to generalize the applicable findings. Moreover, scholars such as Williams (2006) have designed questionnaires that can help to determine an individual's perceived value of social capital. Incorporating such questionnaires into the research design and analyses would extend the available data and add a more subjective, evaluative dimension. Third, as indicated in our argument for the introduction of the SBI, having direct access to (central) actors within a network is no longer required to gain access to valued resources (pieces of information) within SNSs. More specifically, if an individual is not part of the giant component—for example, the user does not mention or reply to another Twitter account, or merely reads the information from a certain hashtag conversation and therefore does not show up in the data set—how can we assess that individual's social capital? These types of scenarios are inherently difficult to measure within SNSs. Some scholars have attempted to reveal possible underlying mechanisms using questionnaires (e.g., J.-W. Lin et al., 2015; Sumner et al., 2014) or more qualitative research approaches generally (e.g., Fox & Wilson, 2015; Lee et al., 2015). Future research should build on these considerations and consider possible ways to tap into these types of information resources. Finally, although the simplicity of the proposed metric contributes to the ease of use, it also has drawbacks. More specifically, it does not fully account for differences in levels of in-degrees and out-degrees when rescaling the degree difference. Hence, the initial scaling effect, representing the difference between very active and very passive participants, still must be fully accounted for. Additionally, to further enhance its interpretative value, future research should further refine the metric and strengthen the link with other established metrics. By following these suggested pathways, we would be able to gain additional insights into how individuals shape their role within (online) SNSs such as Twitter, how this affects their network position, and how the content being shared might be influenced by certain groups of participants. It would also allow us to investigate whether and to what extent individual accounts transition between SBI roles over time, thereby adding a dynamic component to the analysis of how brokerage roles are taken up and shaped. This in turn would allow us to better understand how (informal) networking is initiated and fostered within SNSs. Moreover, we would attain valuable, additional insights regarding who the driving forces are behind these processes, as well as what kinds of topics are relevant for teachers and educational professionals.

Notes

1. This calculation was done with the help of the Pajek software package and involved a two-step method. First, a classification algorithm was employed that built classes on the basis of the detection of secondary structural holes. Second, the incomplete triads detected were further partitioned into the five brokerage roles, and the total number for each role was summed.
2. For more details on the details of the index, see the Technical Appendix.

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APPENDIX

In this appendix, we provide more details on how the social brokerage index (SBI) was constructed. We normalized the degree difference for each individual Twitter user account in our data set and then rescaled this metric on a scale from -1 (very passive) to +1 (very active), using this formula:

(TA 1)

$$diff_i^{Degree} = (diff_{max}^{Degree} - diff_{min}^{Degree}) * \frac{degree_i - degree_{min}}{degree_{max} - degree_{min}} + diff_{min}^{Degree}$$

, where

$diff_i^{Degree}$: rescaled, normalized degree difference for individual i

$degree_i$: normalized degree difference for individual i

$degree_{min}$: minimal value of all observed normalized degree differences

$degree_{max}$: maximal value of all observed normalized degree differences

$diff_{min}^{Degree}$: minimal value of the new scale, which in our case is -1 (very passive)

$diff_{max}^{Degree}$: maximal value of the new scale, which in our case is +1 (very active)

We then determined four subcategories within the measure's scale, which were based on the underlying quartiles and represent:

very passive ($-1 \leq x < -0.5$)
 mostly passive ($-0.5 \leq x < 0$)
 mostly active ($0 \leq x < 0.5$)
 very active ($0.5 \leq x \leq 1$).

Finally, we provide two calculated examples, in the context of the #edchat hashtag, for SBI 1 (social hub) and 4 (social influencer). In case of SBI 1, one user account was identified as @mindshiftkqed, which is a portal that “explores the future of learning in all its dimensions” (www.kqed.org/mindshift/). During the time span that we investigated, this account mentioned 34 other users, which was equivalent to their out-degree centrality measure. In contrast, the same account was mentioned 3,782 times by others, which was their in-degree centrality measure. Using our equation, we found that this equated to a rescaled, normalized degree difference of -0.99, which in turn put the account into the SBI 1 category. Focusing on SBI 4, we identified @edgаметec as a representative of this particular category. This account mainly deals with educational technology and gaming, specifically indicating that it would retweet any tweets containing certain hashtags (e.g., #games4ed). This account mentioned 4,133 other Twitter user accounts (out-degree) but was only directly mentioned by six other users (in-degree). Again, using our formula, this equated to a rescaled, normalized degree difference of 0.99, which put the account into the applicable SBI category.

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