

#2016-052**The invisible hand of informal (educational) communication!?
Social capital considerations on Twitter conversations among
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The Invisible Hand of Informal (Educational) Communication!? Social Capital Considerations on Twitter Conversations among Teachers¹

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Abstract

Twitter can contribute to the continuous professional development of teachers by initiating and fostering informal learning. Social capital theory can aid to analyse the underlying communication processes and outcomes. Yet, previous research has largely neglected teachers and the role of social capital on Twitter. The present study addresses this shortcoming by analysing a hashtag conversation among German speaking teachers. Using social network analysis, we are able to show the relevance of the structural dimension of social capital in Twitter conversations among teachers.

Keywords

informal learning
teacher professional development
social capital
social network analysis
social media

JEL Classifications

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I28
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1. Informal Learning and Social Media

There is an increasing need for teachers to develop and implement new, collaborative, approaches to learning (Finsterwald, Wagner, Schober, Lüftenegger, & Spiel, 2013). In order to achieve this goal, educational professionals in general, must continuously update and expand their knowledge and skills to meet the challenges of today's world (Chalmers & Keown, 2006).

According to Richter and his colleagues (2011), this type of professional development cannot be achieved through short-term interventions. Instead, a more long-term process needs to be initiated, which expands beyond the confines of formal teacher education and extends into the everyday working environments of teachers. Similarly, Fox and Wilson (2015) established that teachers should not rely solely on formal support roles and institutions. Instead, they should rather draw on formal and informal learning networks wherein they can share their ideas and collaboratively reflect on their practice. Here, we follow the definitions of Richter, et al. (2011), and define formal (e.g. traditional) learning as “*structured learning environments with a specified curriculum*” (p. 117), and informal learning as “*not follow[ing] a specified curriculum and [...] not [being] restricted to certain environments*” (p. 117). Contrasting these two types of learning, Hofman and Dijkstra (2010) conclude that in light of “*the failure of most professional development efforts*” (p. 1031), informal learning networks can contribute to capacity building of teachers by providing a platform to engage into a collaborative exchange of insights and experiences. Moreover, Conlon (2004) suggested that about 90 percent of professional development actually takes place in an informal setting, rather than in a formal one. An empirical study by Boyle and colleagues (2005) showed that these considerations are in line with the perceptions of teachers themselves. More specifically, in their study among secondary schools across England, they discovered that sharing practice is perceived as an important element for longer-term professional development activities. Even more so, Hattie (2013) found that these types of teacher-driven activities tend to be more effective than top-down interventions that are part of a larger and more formal professional development initiative. Hofman and Dijkstra (2010) attributed this observation to the “*one-size-fits-all set of solutions*” (p. 1031), which is generally prescribed by experts from outside the regular school context (e.g. ministries, universities). These solutions fail to account for individual differences in experience, teaching style, as well as differences in the larger, classroom-type, circumstances. Furthermore, rather than “*relying on one-shot workshops to enhance skills*” (Butler & Schnellert, 2012, p. 1207), informal learning networks provide teachers with an opportunity to continuously share and update their practice and engage into collaborative informal professional learning (Hopkins, 2000). This also offers greater flexibility than traditional teaching and learning scenarios (e.g. Choi & Jacobs, 2011; Froehlich, Beausaert, Segers, & Gerken, 2014; Marsick & Watkins, 1990). Consequently, informal learning can serve, not only as a building block for the individuals' professional development, but also as a contribution to the success of the larger context (e.g. Kyndt, Dochy, & Nijs, 2009). Eraut (2004) distinguishes between three different types of informal learning, namely *implicit*, *reactive* and *deliberative learning*. *Implicit learning* takes places always and everywhere, while the individual is not aware of the actual learning process. For example, snooker players know a great deal about angles and rotations, arguably without knowing the underlying physical principles. In the context of *reactive learning*, the individual is aware of the learning process. However, these incidences happen spontaneously in a specific context, and while executing a particular action. For example, trade representatives learn a lot about applying different sales strategies, while being in direct contact with their clients. *Deliberative learning* differs from the other two types of informal learning in that an individual is explicitly aware of the learning process. Here, employees deliberately take time to think about how and where they can gather new information and insights, thereby initiating their own continuous professional development. A prime example for this type of informal learning is a conference. Such an event provides a ready-made space to share information with colleagues and acquire new insights, thus promoting an informal learning process.

Nowadays, the rise of social media has led to a panoply of online communication spaces or sites, such as Facebook, LinkedIn and Twitter, wherein individuals can communicate with one another and which lend themselves to deliberative learning. On the basis of their structure and general characteristics, these platforms connect individuals via networked devices, such as computers (Wellman, 2001). Consequently, these platforms are also referred to as *social networking sites* (SNS). Apart from recreational purposes (e.g. sharing holiday photos and pet videos), these spaces are increasingly used as places for professionals to meet and discuss current topics and problems relevant to their profession. Additionally, there has been a growing amount of research that investigated the potential of SNS for informal learning. More specifically, a growing number of studies have shown that teachers use Twitter to keep up-to-date with the latest news on education and share resources with colleagues (Risser, 2013). This observation is paired with more theoretical considerations by scholars like (Marotzki, 2004), who suggest that social media provides us with an unprecedented opportunity to exchange information and experiences, while connecting with other people and learning from and with each other. These platforms essentially provide informal learning spaces that can initiate professional development processes

(Spanhel, 2010). However, in contrast to formal learning spaces, the focus here is not primarily on the acquisition and transfer of knowledge. Instead, it is rather a question of the "*contextualization, flexibility, decentralization, pluralization of knowledge and experience patterns, or [...] the opening of indeterminacy spaces*" (Marotzki & Jörissen, 2008, p. 100). When you enter such spaces, neither learning nor knowledge creation, are guaranteed. Instead, they provide an opportunity for informal, professional development by enabling individuals to engage into discussions with a wide variety of other individuals (Tynjälä, 2012) and by stimulating them to critically reflect on their actions (Kolb, 1983). We therefore argue that social networking platforms constitute *social opportunity spaces*, which provide the meta-context wherein knowledge creation is fostered, and learning processes are stimulated, by the complex interplay of various underlying relations and factors (Spanhel, 2010). Yet, while such behaviour could be beneficial, researchers have stipulated that individuals' worry about jeopardising their position within their networks (Wasko & Faraj, 2005). Hence, the question arises as to whether SNS really constitute *social opportunity spaces*, in which informal learning and the continuous professional development of teachers can be initiated and fostered.

1.1. Social Capital in Social Networking Sites

In the last few decades a common conceptualisation of social capital, and its most important enablers, has formed in the social sciences where we can see social capital formation taking place in an environment in which communities "own" and share the solutions to collective problems, specifically those that formal institutions have failed to solve (Bowles & Gintis, 2002). According to Lieberman (2000), networking platforms, such as the in the previous section mentioned SNS, provide such a ready-made environment for informal learning and problem solving processes, as their structure is "*loose, borderless and flexible*" (p. 221). As such these platforms allow teachers to collaboratively organise around their needs and interests in an informal way.

In this context, educational scientists have increasingly acknowledged that the concept of social capital can contribute to our understanding of how informal learning networks develop and evolve over time (e.g. Moolenaar, Slegers, & Daly, 2012; Risser, 2013). Even more so, social capital has been identified as a useful concept to explain the potential benefits teachers can accrue from networking (e.g. Fox & Wilson, 2015) and has already been used to help understand teachers' professional development (e.g. Baker, Doyle & Yoon, 2011). Rienties and colleagues (2013) stipulated that the formation of social capital facilitates information flows, individuals' willingness to share experiences, and the opportunity to attain valuable information from outside one's regular working environment. According to Hofman and Dijkstra (2010), social capital therefore allows us to capture the value of informal learning networks "*as a resource that teachers can draw upon to improve their teaching*" (p. 1032). According to Tsai and Ghoshal (1998) social capital can further be defined as "*relational resources embedded in the cross-cutting personal ties*" that "*are useful for the personal development of individuals*" (p. 464). Moreover, particularly in the context of learning and professional development, social capital is often associated with human capital. Here, Coleman (1988) stipulates that social capital contributes to the formation of human capital. However, it is important not to confuse or treat them as equal. Instead, "*social capital [is a] quality created between people, whereas human capital is a quality of individuals. [...] human capital refers to individual ability, social capital refers to opportunity*" (Burt, 1997, p. 339). Social capital can thus be considered as a component of human capital, which can play an important role in informal learning. Nahapiet and Ghoshal (1998) distinguish 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 SNS, while the *cognitive dimension* deals with the question of whether participating actors share a common understanding and terminology, which improves the potential of exchanging ideas and information, and finally the *relational dimension* describes issues such as trust and common values among individuals.

Yet, while previous research has already touched upon this topic, these studies can be criticised on the basis of five main issues. First, while social capital in SNS has already been identified and analysed in a number of SNS settings, considerable uncertainty remains about the specific role of social capital in the context of informal learning (e.g. Boyd & Ellison, 2007) and how it evolves over time (e.g. Panzarasa, Opsahl, & Carley, 2009). Moreover, prior research remains ambiguous on the process of social capital formation. While some scholars have argued that SNS provide individuals' with equal access to social capital formation (e.g. Lin, 1999), others have stipulated that dominant individuals and groups can control communication and impose limits on other individuals' opportunity to gain social capital within SNS (e.g. Bourdieu, 1986). Second, numerous studies have been conducted among students, and while these studies have provided valuable insights on the topic, research on SNS and social capital in the context of professional development and informal learning remains scarce (e.g. Eraut, 2004). Third, previous research on SNS has largely dealt with Facebook and has neglected other SNS, such as Twitter. Fourth, continuous disagreement exists among researchers as to whether social capital bonds people together, or bridges gaps between otherwise disconnected people and spaces within SNS. The *bonding* argument is propagated by the proponents of Coleman (1988). Here, the assumption is

that social capital is mainly, if not exclusively, manifested in closed network structures. Individual participants are in close contact and form a group with only single and sporadic connections to others outside their “group” or “space”. The closed structure contributes to the development of *trust and norms* between the participating individuals. This, in turn, then promotes a *reciprocal* exchange of information and experiences, which further strengthens the connection of the participants. The *bridging* argument stipulates that the value and potential of social capital is based on something that Granovetter (1973) has described as “*weak ties*” (p. 1360). People with whom we have regular contact, can rarely share information and insights that are really new to us. Gargiulo and Benassi (2000) describe such a situation as a “*cognitive lock-in*” (p. 186), which negatively affects the opportunities for developing new ideas and approaches. Fifth, teachers have largely been neglected from the analysis of informal learning and social capital formation within SNS. The present study addresses these shortcomings by investigating whether conversations on Twitter have the potential to contribute to informal learning among teachers. It furthermore takes a deeper look at this process in order to investigate whether, and to what extent, participation in SNS contributes to social capital formation.

2. Research Questions

Focusing on the *structural* dimension of social capital and building upon on the aforementioned considerations and perceived gaps in prior research, we formulate our four main research questions as:

1. Does Twitter constitute a *social opportunity space*?
2. If so, does it provide an environment in which informal learning among teachers can be initiated and fostered?
3. To what extent do Twitter conversations contribute to the formation of teachers’ social capital?
4. Is the network formation process sustained and regenerative over time?
5. Is it possible for individuals to attain a central position within a Twitter conversation network that would possibly allow them to dominate this Twitter conversation?
6. Which role (*bridging* or *bonding*) does social capital play in Twitter conversations among teachers?

3. Data

Twitter is a light-weight 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 the communication with other users, e.g. via direct messages, 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, Fang, He, & Hsieh, 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, which enhances their possibility to access networks and further develop their already existing ones (Letierce, Passant, Breslin, & Decker, 2010). Moreover, by providing individuals with the possibility to connect, they thereby also constitute a ready-made environment to investigate the importance of social capital within SNS. In the context of this study, we will focus on the hashtag #EDchatDE. This conversation constitutes a weekly live-chat, lasting for one to two hours, which covers the latest trends and developments in education, as well as the integration of (new) media into the lesson plans and broader curricula. While the conversation also incorporates an international audience, it mainly focuses on German speaking countries. We consider this hashtag to be particularly interesting, as German teachers are not obliged to partake in professional development programs (Avenarius & Heckel, 2000). Consequently, an investigation of this hashtag conversation provides an opportunity to gather insights on how teachers exchange ideas and experiences in a context where they really cannot rely on formal support roles and institutions (Fox & Wilson, 2015). Using NodeXL, the data was collected over a period of one year, from the 22nd of May 2014 through to the 21st of May, 2015. The collected data was then imported into the Pajek software to conduct social network analyses (SNA).

4. Method

The core contribution of this study revolves around answering the questions on whether SNS, such as Twitter, are able to connect teachers, thereby providing a meta-context in which informal learning processes can be initiated and supported over longer periods of time. Using Twitter data from the #EDchatDE conversations between teaching professionals, we apply SNA methods focusing on the *structural* dimension of social capital

formation (Nahapiet & Ghoshal, 1998). First, we collected data on the Twitter users that have contributed to the applicable hashtag conversation (Bruns & Stieglitz, 2013). This included the amount of Tweets they had posted in general, the amount of people they followed (Followed) and that were following them (Followers), as well as the year when they created their Twitter account (Twitter Birth). Subsequently, we then build directed unweighted 1-mode networks based on “Tweets”, “Mentions”, and “Replies to” matrices.

Then, secondly, we conducted SNA, to identify the underlying network structures of #EDchatDE. SNA has been widely acknowledged as a valuable tool to assess the *structural* dimension of social capital (Moolenaar et al., 2012; Rienties et al., 2013; Tsai & Ghoshal, 1998). Within SNA there are a number of metrics which have been developed, that can be computed, and which present the structural characteristics in social networks (Grabowicz, Ramasco, Goncalves, & Eguiluz, 2014). The internal links and the links between groups within the network are initially the most interesting to explore, to get an idea of reciprocity and the intensity of the information exchanged through the hashtag discussions. We have therefore computed the *in-*, *out-*, and *overall* degree centrality metrics of all users taking part in the hashtag discussion. These metrics provide an indication of how often an individual has been contacted or has contacted others, respectively. In order to estimate whether the underlying discussion might have led to *bonding* social capital, we determined users’ *closeness* centrality (e.g. Coleman, 1988; Lin, 1999). *Bridging* social capital was assessed using *betweenness* centrality (e.g. Burt, 1997) and *brokerage positions* (e.g. Burt, 2009). In order to determine individuals’ brokerage positions, we followed the work of De Nooy and colleagues (2011), who distinguish between *coordinator*, *itinerant broker*, *representative*, *gatekeeper*, and *liaison*. How these roles translate into actual network positions is highlighted by Figure 1 below. 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).

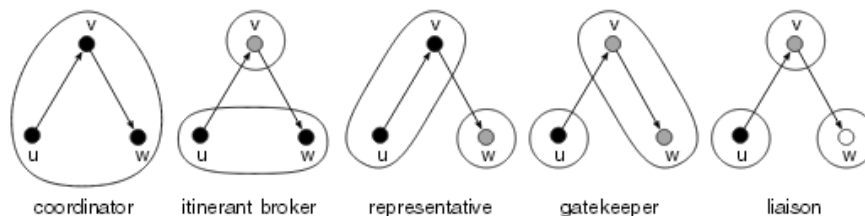


Figure 1. Possible Brokerage Roles for an Individual within a Network (De Nooy et al., 2011, p. 151)

Third, we ran a cluster analysis with the aim of identifying possible subgroups of users within the #EDchatDE network (Java, Song, Finin, & Tseng, 2007). Taking into account the directed nature of Twitter conversations, we have used the Louvain-Method to cluster our data and to identify subgroups (Blondel, Guillaume, Lambiotte, & Lefebvre, 2008).

Fourth, we implemented a comparison in which we re-calculated the main network metrics previously mentioned on a random, artificially generated network with similar properties as our focal Twitter network. In general, while studying a particular SNA case it is difficult to judge whether any of the calculated outcomes are “good”, “bad”, “high” or “low”. Randomly generated networks, which are based on the characteristics of the observed network, are a robust means for creating a benchmark with which to compare the studied case. Generally, the degree distribution within social networks follows a power-law. Figure 2 below provides a visual representation of such a distribution.

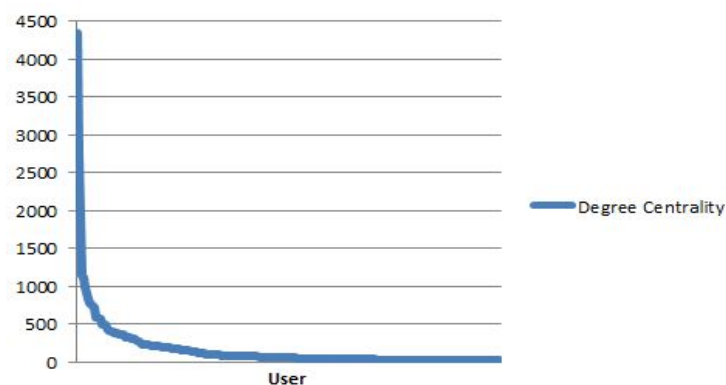


Figure 2. Distribution of Degree Centrality in an Exemplary Scale-Free Network

Each individual scale-free network will have a unique distribution. However it is possible to generate such a scale-free network based on the same number of vertices with the same number of edges and the same average degree distribution as the original network (e.g. Batagelj & Brandes, 2005; Pennock, Flake, Lawrence, Glover, & Lee Giles, 2002). Based on this random scale-free network, we can then calculate the same network metrics as for the #EDchatDE network and use them as control measures to assess the magnitude and relevance of the observed data. We then generated a scale free directed network with the same basic characteristics, and a similar average degree distribution, using Pajek (De Nooy et al., 2011).

In order to determine possible links between the different, collected metrics, we computed correlation statistics. Testing for the normality of the data's distribution revealed a violation of the parametric assumption for all measured social network metrics. Consequently, we used Spearman's rho (r_s) to determine correlations, and Mann-Whitney (U) tests to assess differences between #EDchatDE and our scale-free model.

5. Results

Overall, 79 754 contributions from 4196 unique Twitter-Users were collected. These contributions were then subdivided into 20 204 "Tweets", 41 694 "Mentions" and 17 856 "Replies to" other users. Table 1 provides an overview of the users' background characteristics. As can be seen from the table, there has been a considerable range in the collected metrics, particularly for "Followers". A closer look at this particular metric revealed that those users that had a higher than average amount of "Followers" belonged predominately (78%) to accounts owned by large, international corporations and news portals, such as YouTube, New York Times, Google, TedTalks and Edutopia. In terms of users' "Twitter Birth", there has been an even distribution across the time spectrum with 43% having older accounts than the average and 45% of users having created their accounts after the mean date.

Table 1. Overview of Twitter Users' Background Characteristics

	Mean	Stdev	Min	Max
Followed	1408.80	6430.27	0	217 876
Followers	49 483.92	1 044 649.86	0	53 035 721
Tweets (Overall)	11 148.92	30 035.62	0	745 953
TwitterBirth	2011	2.19	2006	2015

A graphical representation of how the number of "Tweets", "Mentions" and "Replies to" have changed over time is presented in Figure 3. It is apparent that "Mentions" were the predominant mode of communication, while "Tweets" and "Replies to" reached comparable levels. Moreover, these trends were subject to considerable fluctuations. Yet, the differences between each of the types of communication did not change significantly. Furthermore, there were three noticeable drops in participation, which could be linked to the German holiday periods, in which teachers, the main target audience of #EDchatDE, were obviously not engaged in any work related activities.

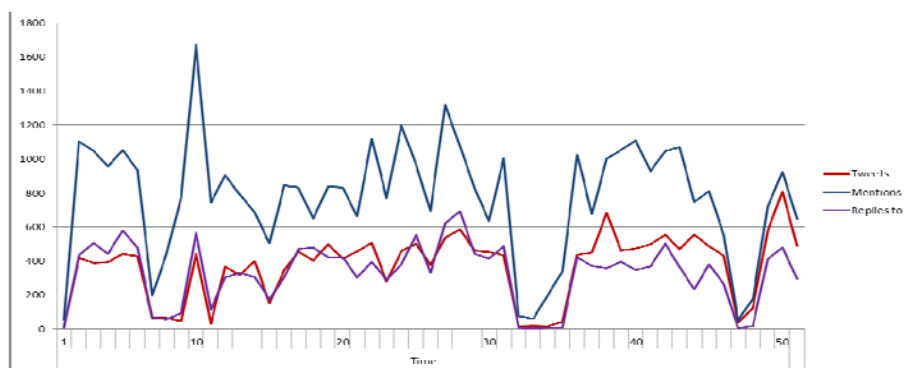
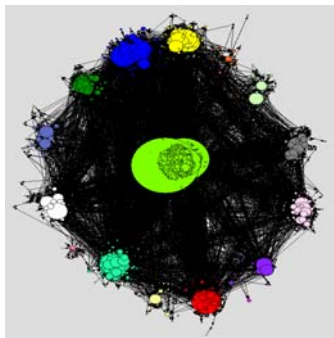


Figure 3. Longitudinal Data on #EDchatDE (Weeks)

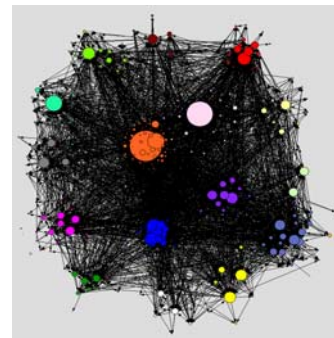
The results of our social network analysis are provided in Table 2 below. As the partial focus of this paper was on social capital formation and relevance of *bridging* and *bonding* social capital, we investigate the “Mentions”- and “Replies to”-networks in our further analyses. Generally, a high standard deviation for the degree centrality measures could be observed. Furthermore, while the overall level of the applicable measures remained low, the data suggested that *closeness* centrality (*bonding* social capital) was more pronounced than *betweenness* centrality (*bridging* social capital). Furthermore, the descriptive statistics indicated significant differences between the observed #EDchatDE conversation and our random scale-free model. In order to statistically test this observation, we conducted a Mann-Whitney (U) test, which further supports this notion. The results were highly significant for all determined network metrics. Yet, while participation in the hashtag conversation did appear to be less evenly distributed than expected, based on our model, #EDchatDE did not seem to provide individuals with a platform to attain central positions in the overall network and therewith the possibility to dominate the discussion. In order to follow-up on this observation, we determined underlying sub-clusters using the Louvain method for clustering. The results of this clustering exercise revealed a somewhat different picture, as the larger clusters were driven by either a dominant individual, who was able to gather a group, or an online, commercial, portal covering the main topics of discussion. For a graphical representation of these finding, please see Figures 4a and 4b below.

Table 2. Social Network Statistics (#EDchatDE and Scale-Free Model)

	#EDchatDE		Scale-Free Model	
	M	SD	M	SD
Mentions				
<i>InDegree</i>	9.94	109.02	19.59	27.95
<i>OutDegree</i>	9.94	120.74	19.59	28.07
<i>Degree</i>	19.87	228.63	39.18	55.68
<i>Closeness</i>	0.22	0.11	0.34	0.07
<i>Betweenness</i>	0.00	0.00	0.00	0.00
Replies to				
<i>InDegree</i>	4.26	44.97	8.61	12.66
<i>OutDegree</i>	4.26	49.68	8.61	12.91
<i>Degree</i>	8.51	93.64	17.23	25.25
<i>Closeness</i>	0.02	0.04	0.27	0.08
<i>Betweenness</i>	0.00	0.00	0.00	0.00



a) Mentions



b) Replies to

Figures 4a and 4b. Sociograms of #EDchatDE²

In order to further investigate this issue, we took a closer look at the Top 50 participants, regarding their network centrality and how their network position might have changed over time. The graphical representations are provided in Figures 5 (Mentions) and 6 (Replies to) below. As can be seen, there has been a

² Note: Clustering Algorithm = Louvain Method (Single Refinement); Layout: Kamada-Kawai (Optimise Inside Clusters); Node Size = Degree; Criterion for Reduction: min. Degree of 5

considerable amount of fluctuation among the applicable participants' degree centrality. However, it also became apparent that a small subset was able to secure their network position, for both "Mentions" and "Replies to", over time.

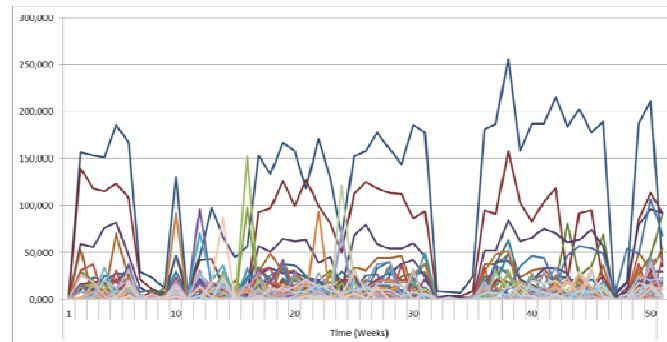


Figure 5. Longitudinal Overview of Degree Centrality for Top 50 Most Central Participants (Mentions)

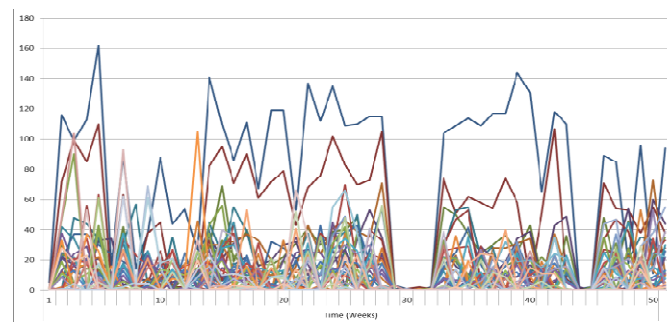


Figure 6. Longitudinal Overview of Degree Centrality for Top 50 Most Central Participants (Replies to)

Finally, and triggered by the findings of our cluster analysis, we determined users' *brokerage positions*. The results are provided in Figure 7 below.

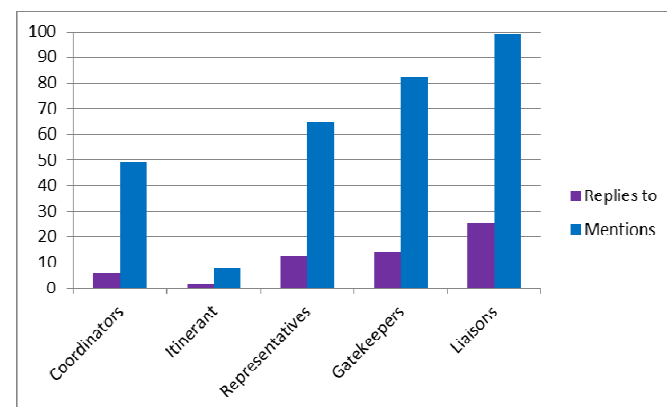


Figure 7. Brokerage Positions for the "Mentions" and "Replies to"-networks

As can be seen, brokerage played only a negligible role in the context of the "Replies to" network. In contrast, within the "Mentions" network, certain brokerage roles were rather dominant. More specifically, *gatekeepers* and *liaisons* were among the most commonly observed roles that individuals took on when connecting otherwise disconnected parties. Again, a *gatekeeper* represents her or his group and is in charge of the incoming information to the group. A *liaison* acts as an intermediary between otherwise disconnected parties from different groups.

6. Conclusion

This study set out to determine whether Twitter can serve as an informal learning space for teachers. More specifically, we were interested whether hashtag conversations on Twitter would contribute to the social capital formation of participating individuals and how this process might change over time. In order to investigate these issues we collected data from the #EDchatDE conversation on Twitter, which constitutes a weekly live-chat, lasting for one to two hours, which covers the latest trends and developments in education, as well as the integration of (new) media into the lesson plans and broader curricula. While the conversation also incorporates an international audience, it mainly focuses on German speaking countries.

Based on the results of this study, we argue that #EDchatDE can be considered a *social opportunity space* (RQ 1). Not only does Twitter allow individuals to keep up-to-date with the latest news on education (Risser, 2013). It also provides an opportunity for a pluralised and decentralised exchange of information and insights with a wide variety of others (Marotzki & Jörissen, 2008; Tynjälä, 2012).

Moreover, taking into account the amount of individuals contributing to the conversation for a prolonged period of time, we also postulate that social networking sites, such as Twitter, provide an environment in which informal learning among teachers can be initiated and fostered (RQ 2). This process of initiating informal learning is mainly fuelled by sharing insights and making each other aware of (new) resources. In the context of #EDchatDE, this can be seen by the high proportion of “Mentions” which have been contributed to the conversation. Individuals are thereby able to expand their horizon and engage into “*environmental scanning*” (Lohman, 2005, p. 505). Interestingly, this finding somewhat contradicts previous research concerning teachers, which stipulated that “*most teachers do not interact in a culture in which teaching-related knowledge is exchanged [...]; [and] they are accustomed to designing teaching activities in isolation [...], which, in turn, prevents knowledge externalization and sharing.*” (Hou et al., 2009, p. 101). We do acknowledge that our data is based on a subset of teachers that has consciously chosen to participate in an online exchange of information and ideas and therefore leave their “*narrow daily existence*” (Williams, 2006, p. 600). However, the results of this study indicate that social networking sites might be able to “break the cycle” and offer new possibilities for teachers to get connected with others, simultaneously fostering a process of externalising and sharing information.

The third research question was concerned with the extent with which Twitter conversations contribute to the formation of teachers’ social capital (RQ 3). Based on our results, we conclude that participating in a hashtag conversation on Twitter does indeed contribute to individual teachers’ formation of *structural* social capital. We follow the work of Tsai and Ghoshal (1998) and define social capital as “*relational resources embedded in the cross-cutting personal ties*” that “*are useful for the personal development of individuals*” (p. 464). Hence, taking into account the social network metrics we have determined, particularly the degree centrality measures, we are able to provide evidence that #EDchatDE has contributed to interpersonal ties between teachers who took part in the conversation.

Furthermore, the longitudinal aspect of this study, which looked at how the network formation process evolved over time (RQ4), showed that new ties occurred and individuals’ personal networks thereby increased over time. Following our definition of social capital, we therefore argue that this has then also provided favourable conditions for individuals to increasingly gain access to relational resources and knowledge.

Our data also shows that certain individuals are able to attain central positions within the Twitter conversation (RQ 5), which they are then able to sustain over time. More specifically, by combining our centrality metrics with the results of the cluster analyses, we show that sub-clusters gravitate around one or a few key actors. Interestingly, this holds true for both types of networks we considered, namely the “Mentions”- and “Replies to”-networks, as well as for both types of degree centrality measures, e.g. in- and out-degree. The applicable individuals’ position can therefore be said to be based on a “give and take” relationship with others. They include others when sharing information (“Mentions”) and contact them (“Replies to”), as indicated by their out-degrees. These interpersonal ties are then reciprocated by others, as the applicable in-degree measures indicate. This can be considered as additional support for our postulation that Twitter conversations contribute to the formation of social capital among teachers. Individual actors engage into creating and sustaining interpersonal ties. As a result, they are able to attain more central positions in the network. This in turn provides them with access to more and more diverse, sources of information, which can initiate and foster a process of informal learning (e.g. Fox & Wilson, 2015). However, the longitudinal data also showed that, while some changes did occur within the individual sub-clusters, there have not been any significant changes in the composition of central individuals therein. Consequently, it seems that these individuals might be able to dominate discussions and steer the conversation into directions that they deem more interesting or preferable. This notion is further strengthened by our comparison between the factual #EDchatDE network and our scale-free, random network model. As the results of our Mann-Whitney (U) tests were statistically significant, we can conclude that the prevalence of central individuals is more pronounced than a random model would predict. This in turn provides support for the considerations of scholars like Bourdieu (1986), who stipulated that dominant

individuals and groups can control communication and impose limits on other individuals' opportunity to gain increased social capital within SNS.

The final research questions dealt with the question of what type of social capital (*bridging* or *bonding*) is accumulated within the Twitter conversation at hand (RQ 6). Generally, considering the overall network structure, our data suggests that *bonding* social capital might have been more dominant within the #EDchatDE conversation. This observation is further strengthened by the cluster analyses, which highlighted internally well-connected subgroups within the overall network. However, at this level of analysis, we have discovered that mainly the central individuals of the subgroups are able to accumulate *bridging* social capital as well. More specifically, by determining their *brokerage positions*, we are able to show that they can act as intermediaries (e.g. *gatekeeper*, *liaison*) between otherwise disconnected individuals. As a result, they attain positions that allow them to exercise influence on what type of information is circulated within a certain subgroup. While Twitter is an open communication channel that can be accessed by anyone without any limitation and irrespective of membership to a certain subgroup, we believe that brokerage positions are nonetheless a meaningful measure to consider. Over the duration of the data collection process, 79 754 contributions by 4196 unique Twitter-Users were added to the #EDchatDE conversations. Consequently, it can be argued that it will be difficult for an individual to monitor and digest that full amount of information that has been shared among participants. Therefore, individuals might have a tendency to focus on information that they receive from a subset of the overall network. According to our data, this is likely to be either information from the subgroup that they belong to, or from central brokers they know from other parts of the network. While the first option contributes to *bonding* social capital, the second option adds to *bridging* social capital.

6.1. Limitations and Future Research

This study, although rich in descriptive and analytical data, exhibits three main limitations that can provide valuable input to future research in this field. First, our results can only be generalised in so far as that we use benchmark values from our scale-free, random network model. In order to be better able to generalise on our findings, future research should conduct comparative studies with other, similar hashtag conversations that exist among teachers on Twitter. More specifically, it would be interesting to also investigate social capital formation in contexts such as #educhat. This would be particularly interesting as #EDchatDE mainly targets German teachers, who do not have to partake in (formal) professional development programs (Avenarius & Heckel, 2000). In contrast, their American colleagues, who are targeted by #educhat, are generally obliged to attend professional development activities (Richter et al., 2011). This in turn might impact individuals' incentive and goals when joining Twitter conversations. Second, in this study, we focused on the *structural* dimension of social capital. While this has been a widely used approach to analyse the concept of social capital in social media (e.g. Grabowicz et al., 2014; Lin, 1999; Tsai & Ghoshal, 1998), it neglects the content of the conversations (*cognitive* dimension of social capital), as well as possible underlying reasons why individuals have chosen to join a particular Twitter conversation (*relational* dimension of social capital). In order to provide a more complete picture of the practical relevance of the theoretical model of social capital, future studies should ideally also investigate these currently lacking dimensions and determine possible interaction effects between the three dimensions. Third, the current data is based on user statistics from Twitter. While this approach allows for an objectified view on how individuals behave on social networking sites (e.g. Hofer & Aubert, 2013), a range of questionnaires have been developed (e.g. Williams, 2006) to determine the perceived value of social capital from an individual's personal perspective. Including these types of tools in future research and combining them with the social networking measures of this study would extend the analysis and add a more subjective, evaluative dimension. By following these suggested pathways we would be able to gain additional insights into whether, and to what extent, social capital plays a role in SNS, as well as whether there are reliable and replicable "investment strategies" for social capital within SNS. This in turn would allow us to better understand how informal learning are initiated and fostered within *social opportunity spaces*, such as Twitter. Moreover, we would attain valuable, additional insights on who are the driving forces behind these processes, as well as what kind of topics are relevant for teachers.

7. References

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