

**“Newbies” and “Celebrities”: Detecting social roles
in an online network of teachers via participation patterns**4
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Abstract The advent of social networking tools allows teachers to create online networks and share information. While some virtual networks have a formal structure and defined boundaries, many do not. These unstructured virtual networks are difficult to study because they lack defined boundaries and a formal structure governing leadership roles and the transfer of information. The purpose of the study was to explore the relationship between how a member participates in a virtual blog network and the role of that member in the network. Unlike previous studies that use behavioral or structural characteristics of an individual's network to infer social roles, this study utilized cluster analysis to combine behavior and structural information in role detection. Quantitative methods from social network analysis were used to compare the network structure of individual bloggers both across and within groups. The results indicate that how an individual participates in the network has an influence not only on their current role in the network, but also in how and how quickly their role in the community changes.

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22**Keywords** Blog communities · Participation · K-12 Teachers23 Q1
24**Introduction**

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Research over the past few decades in the area of professional learning shows a shift from an acquisition model of professional learning to one of participation as learning and knowledge in practice (Barab and Duffy 2000). This shift from the individual context to a socio-cultural context emphasizes collaboration between learners and focuses on the context within which these interactions take place (Hansman and Wilson 2002). Research on teacher participation in virtual professional networks suggests that this participation supports reflection on the practice of teaching (Hough 2004; Killeavy and Moloney 2010; Lock 2006; Ray and Hocutt 2006) and can be a catalyst for implementation of reform based teaching methods (Luehmann and Tinelli 2008). Schlager, Fusco, and Schank (2002) suggest that this engagement in practice with other

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practitioners can provide “continuity and cohesion of professional development” (p.205) to support and sustain changes in practice.

Traditionally, teachers’ professional networks have been created via formal structures within the school (e.g., teams, departments) and formal structures from outside the school (e.g., university cohorts, professional organizations). The advent of online social networking tools has allowed teachers to develop professional relationships online as well. These online interactions might be a complement for face-to-face interactions (Yang 2009) or could be the only mode of interaction between two teachers (Gray 2004). In both studies of computer supported collaborative learning spaces and teacher communities, researchers have attempted to identify the informal roles that individuals occupy within a network (Baker-Doyle and Yoon 2011; Coburn and Russell 2008; Daly and Finnigan 2010; Moolenaar et al. 2012; Strijbos and de Laat 2010). Typically these studies have used either interviews (for example, Baker-Doyle and Yoon 2011; Moolenaar et al. 2012) or qualitative analysis of textual content (for example, Sing and Khine 2006; Strijbos and de Laat 2010) to determine the roles individuals occupy within the network. For large communities, these types of qualitative analyses are extremely time consuming. Recently, emphasis has shifted to using quantitative measures from Social Network Analysis (SNA) to identify roles (for example Marcos et al. 2006). The benefit of using quantitative methods from SNA is that the analysis can be done quickly even for large communities. However, these strictly structural measures have been criticized because they ignore both an individual’s behaviors (e.g., frequently posting answers to questions posed by others) and contextual information that may influence relations with others (e.g., how long an individual has been engaged with the group) (Gleave et al. 2009). The purpose of this paper is to demonstrate how cluster analysis can be used to combine structural and behavioral/ contextual data in order to better determine an individual’s role in an online network.

Theoretical and Empirical Perspectives

In this paper we draw upon two primary theoretical frameworks to situate our analysis and discussion: Communities of Practice (CoPs) and Affinity Spaces. Knowing in action as described by Amin and Roberts (2008) is an effort to push back against the ubiquitous and generic use of the concept of communities of practice. We benefit from their thoughtful critique of community of practice in educational research and used their work in applying community of practice in our study. We contend that the lens of participation as characterized by Lave and Wenger (1991) and Wenger (1998) allows us to explicate the interactions and participation within this virtual space in terms of knowing in action. We are not suggesting that individuals in the network perceive membership in a community but rather that this networking space provides an opportunity for practitioners to discuss their work with one another and to learn with and from each other through their interactions and participation. Since the space (e.g., blogs) helps to support and define interactions between members of the network, we also draw upon the work of Gee (2005) regarding affinity spaces. Affinity spaces (Gee 2005) while similar to CoPs in some way, put the focus on shared interests and interactions instead of on membership in a shared profession. These theories embody aspects of two different types of knowing in action described by Amin and Roberts (2008): Professional knowing and Virtual knowing. Professional knowing most closely fits how we conceive of CoPs in this work. Members of these professional knowledge communities share a common vocation. The interactions between community members help to build both tacit and codified knowledge. Virtual knowing most closely fits the theory of affinity spaces (Gee 2005) as all the interactions occur in a virtual space. Although Amin and Roberts (2005) make the argument that

knowledge generation is not typically a common goal of loosely knit online communities, they specifically reference other studies suggesting that virtual communities of teachers can engage in virtual knowledge creation. Amin and Roberts (2005) are careful to point out the difference between interactions that support individual information foraging and interactions indicative of mutual engagement and knowledge generation.

Blog Structure

Individual members of a blog community are connected by hyperlinks. There are three different types of hyperlinks on blogs: blogrolls, citation links, and comment links. A blogroll is a list of other blogs that typically appears as a sidebar on the blog. A blogroll link might serve a number of different social purposes (Schmidt 2007). Some authors, more commonly known as bloggers, use their blogroll to recommend other blogs to their readers while others use it to keep track of blogs they regularly read. A blogger lists other blogs on a blogroll if they like the other blogs. Citation links on the other hand can be indicative of both agreement and disagreement with another blogger (Schmidt 2007). Citation links are hyperlinks to other blog posts that are embedded in the post of a blogger. A blogger could make a citation because they like what another blogger had said or because they disliked the other blogger and/or post. A blogger is not necessarily made aware when they are cited or listed on the blogroll of another blogger. Thus, both blogroll and citation links represent unidirectional connections between two bloggers. The final type of link is a comment link. When a blogger makes a post, another blogger can make a comment on that post. Often the comment includes the name of the commenter and a hyperlink back to the commenter's own blog. A commenter may use the comment to agree or disagree with the original blogpost. No matter the motivation of the commenter, comments are indicative of an interaction between two bloggers in the community.

In theory, one blog can include multiple types of links to another blog. For instance, one blog might contain both a blogroll link and a citation link to another blog. When Ali-Hasan and Adamic (2007) examined the linking practices of two different blogging communities, however, they found that only 21 % of bloggers linked to the same blog in multiple ways. The majority of links between blogs were single links rather than multiple links. Effimova and Hendrick (2005) suggested that identifying community norms concerning linking are important before beginning mapping the community using hyperlinks. Some blogging communities prefer to follow other bloggers using an RSS feed instead of a blogroll. For these types of communities, blogroll links might not give a complete view of the community. These findings and the findings of other researchers (Mislove et al. 2007), imply that when hyperlinks are used to study blogs, multiple types of hyperlinks should be used to detect relationships. Although multiple types of links should be used to discover the members of a network, all links are not created equal. Different types of links may have different meanings for the blogger. Lin, Sundaram, Chi, Tatemura, and Tseng (2007) theorized that blogroll links, the most visible ties between blogs, are carefully selected by the blogger and rarely changed indicating strong relational ties between the two blogs. This suggests that combining different types of links between blogs might not capture the full meaning of the relationship between two bloggers.

The Theory of Boundary

Although there are some structured blogging networks that have a formal process for accepting new members, many blogs do not belong to structured networks. This makes the boundaries of these types of networks hard to detect. Butlers and Rijke (2007) observed that blogs in the

same community will (a) discuss common interests/topics, (b) link to the same outsiders, and (c) link to one other. A particular group of algorithms, generally termed community detection algorithms, have been used to detect groups of similar blogs in a large network of hyperlinked blogs. Studies of blog networks typically utilize a hypertext crawl to identify potential community members (for example Chin and Chignell 2006; Pikas 2008). A crawl begins with a single blog called a seed. The hypertext links (comment, Citation, or blogroll) from the seed blog to other blogs are identified and added to a list of potentially related blogs. The hypertext links of each blog on the list are added systematically to the list of potentially related blogs. While hyperlinks provide a record of awareness and interaction, it is difficult to discern the social relationship between two bloggers from a single hyperlink. Just because an individual shares a conversation with someone they pass on the street, it does not make them friends. In the same way, not every hyperlink is necessarily indicative of a relationship between two bloggers. Thus, once a list of potentially related blogs is identified, hypothetical constructs of community are often used to prune blogs from the list that do not exhibit evidence of communal ties to other blogs. These constructs might include mutual awareness or connections to the same other bloggers (Butlers and Rijke 2007; Chin and Chignell 2006; Lin et al. 2007), discussion of similar topics or ideas as others in the community (Anjewierden et al. 2005; Butlers and Rijke 2007), or graph structure of the community (Dang and Viennet 2012). At the end of the pruning, the individuals that remain on the community list are theoretically all members of the community.

The theory of CoPs, affinity spaces, and virtual knowing can be used to define pruning criteria that will define the boundary of the network. A CoP “evolves in organic ways that tend to escape formal descriptions and control” (Wenger 1998, p.118). Although there are boundaries of CoPs, they are by their very nature fluid, allowing movement in and out of the community. The boundaries of a CoP are typically defined by a shared expertise or competence (Wenger 1998; Barab and Duffy 2000). However, the term community suggests that “members” will feel a sense of obligation or belonging to the group. This sense of belonging may be difficult to discern in blogging networks. Affinity space theory, on the other hand, does not require that individuals feel a sense of belonging to the group. Instead, the boundaries are defined by a shared interest and a shared space in which to discuss that interest (Gee 2005). In an affinity space, there need not be a shared expertise since both new and expert members will share the same space. Nor do affinity spaces require that participants in the space feel any kinship or belonging with others in the space. While the two theories differ in what expertise is required for participation in the group, both theories are social learning theories at heart. That means that both theories require individuals to engage with others in order to be considered part of the group.

The Theory of Participation

Both affinity space theory and the theory of CoPs support the idea that there are multiple ways an individual can collaborate with others in the network. Lave and Wenger (1991) describe three groups defined by participation: a core group, a group of active participants, and a group of peripheral community members. The emergent and evolving nature of a community of practice (Lave and Wenger 1991; Barab and Duffy 2000) creates a structure that allows members to participate regardless of their length of time or status in the community (Sclager et al. 2002) and to move between groups. In affinity spaces, participation also comes in many forms and participation can change over time.

Online community data can be used to identify patterns of both participation and non-participation in community activities. Chen (2004) studied an online community of high

school students in Taiwan. The study examined how frequently participants logged into the community to read posts on the discussion forums and how often they posted on these forums. Lurkers were defined as those that logged into the community very frequently but posted very infrequently compared to other community members. Researchers like Chen have typically used behavioral rather than structural signatures to quantify participation. While creating a dichotomous differentiation between “lurkers” and “nonlurkers” is a common approach, Leshed (2005) suggested that participation is not a dichotomy but a spectrum. Leshed theorized that two dimensions, intensity and publicity, could be used to quantify community members’ location on a participation spectrum. Publicity refers to the degree of exposure that an individual’s participation takes within the community. For instance, those that read the posts of others would keep their participation private while those that post themselves participate more publicly. Intensity refers to the frequency of engagement within the community. Some individuals will choose to engage daily in community activities while others will choose to participate only monthly. This spectrum view of participation fits the theories of Lave and Wenger (1991) and Gee (2005), in which participation and non-participation can take many forms and participation is constantly in flux.

Centrality Measures and Social Roles

SNA can be a valuable tool in examining how participation in computer supported spaces occurs (de Laat et al. 2007). Centrality measures are structural qualities that help to identify important or influential actors in the network. The most simple centrality measure of a member in a network is degree. The degree of a node is computed by determining the number of direct connections (of geodesic distance one) between the node and the other nodes in the network. In directed graphs, since connections are only one way, we distinguish between inlinks and outlinks by computing two degrees, indegree and outdegree, for each node. In a study of mathematics and science teachers, Judson and Lawson (2007) discovered that teachers that utilized reform based practices had a higher indegree than other teachers in their departments. The researchers theorized that other teachers in the department frequently sought advice from the teachers with reform based expertise. Outdegree, on the other hand, is related to sociability. An individual with a high outdegree might serve as a mentor for others in the network.

Individuals with a high outdegree are influential members of the network and those with a high indegree are considered prestigious members of the community (Hanneman and Riddle 2005). An influential participant in the network will spread information by reaching out, via commenting, to other members of the network. In contrast, an individual with high prestige will communicate information indirectly using his or her own blog. Changes in degree may indicate changes in the role an individual plays in a network. Marcos, Martinez, Dimitriadis, and Anguita (2006) used changing values of indegree and outdegree to measure the changing role of a teacher in an online class. The researchers found that as time passed, the teacher’s importance in the network decreased as the students’ took on more responsibility for their own work. In these previous studies, there was only one type of link between actors in the network. In this study, there are multiple types of connections with different meanings. Individuals with a high comment outdegree might play a different role in the network than individuals with a high citation or blogroll outdegree. Thus in this study we have chosen to separate blogroll and citation degree from comment degree.

The direct number of people that an individual can influence is not the only measure of centrality. Even if one person in the network has more connections they may not necessarily be more central. This is because being friends with a few influential people may make it easier for

an individual to spread information through the network than being friends with a larger number of less influential members. Welser, Gleave, Fisher, and Smith (2007) found that individuals that answered questions of others in a discussion forum tended to have relationships with people that were relatively isolated within the network. These individuals had limited influence on the network as a whole despite having a large number of connections. There are several measures of this indirect influence of an individual on a network. Eigenvector centrality measures secondary influence for an actor by essentially summing the centrality scores for an individual's direct friends (Hanneman and Riddle 2005). As for degree, in a directed graph, eigenvector centrality is measured for both inlinks and outlinks. Another measure of indirect influence is betweenness. Betweenness is the degree to which a node lies on a path between other nodes. Nodes that are high on betweenness are often referred to as brokers of information that can potentially control other members of the network (Scott 2009). Chin and Chignell (2006) theorized that betweenness might be another important measure of influence in blogging networks. Individuals with high betweenness scores might be members of two different networks or subnetworks and help to control the flow of information between these different groups.

Methods

To investigate the relationship between participation and social position we followed teachers that participated in a large unstructured blog network. Although the majority of teachers in this network taught in the United States, 15 of the teachers worked outside the United States. Every participant in the study wrote a publicly available blog. The study was approved as exempt from Institutional Review because the study examined only publicly available blogs. In order to protect the privacy of the bloggers, we have chosen not to identify individual bloggers by name or by the name of their blog. Instead, each blog has been assigned a letter code. In addition, direct quotes from blogs or other data that could lead to the identification of individual bloggers were not included in this publication.

Context and Sample

The blog community was discovered using a seed blog identified through a search of education blogs listed on Edublogs. The blogroll of this seed blog was examined to generate a list of potential community members. Some of the blogs on the blogroll concerned a different topic than the topic addressed on the seed blog. Consequently, not all of the blogs listed on the blogroll were necessarily part of the network. We defined a set of exclusionary criteria. Any blogs that did not meet all of these criteria were eliminated as a potential community member. In this way, we were able to differentiate between blogs inside the boundary of the network and those outside the boundary. The exclusionary criteria were chosen both to ensure that the data was sufficient for the analysis that would be performed and to ensure that potential community members met the criteria set forth by Lave and Wenger (1991) and Gee (2005) for membership in the network. The exclusionary criteria were:

1. *The blog must have a single author*—Multiple authors could theoretically occupy different social positions within the community. Consequently, blogs with multiple authors were not included in the sample.
2. *The blog must include at least 10 posts*—By the end of the study period, the blog had to include at least 10 posts. This criterion was chosen to ensure that there was enough data to

- determine the expertise of the author and to identify if the author was engaged in discussions of their practice with other community members. 263
3. *The blog author must identify their expertise in mathematics and/or science teaching*—In CoPs, members must have expertise in the shared practice. The author of the seed blog had expertise in mathematics and science teaching. So this was chosen as the practice at the center of the community. In order to determine if an author had the necessary expertise to participate in the community, the “About Page” and the last 10 posts were examined. 264
 4. *The author must discuss the mathematics and or science teaching on their blog*—Affinity space theory requires that everyone in the space have interest in discussing the same topic. Teachers that eat lunch together may share a physical space, but not necessarily an affinity for a shared topic. In order to be a member of the network, we required that at least two of the last ten posts discuss a shared interest in mathematics or science teaching. 265

As blogs were added to the network list, the blogs listed on their blogrolls were examined to find other potential community members. This process, called a crawl, was continued until no more additional potential community members were found. At the end of the blogroll crawl, there were 86 blogs in the network. Since blogroll links are typically indicative of longer standing relationships between bloggers, newer bloggers may not appear on any blogrolls. Thus, a comment crawl of was conducted as well. The comment crawl examined the comments made on the blogs during the time period of the study. Anyone that made a comment on a blog during the time period was listed as a potential network member. The blogs of each commenter were examined in order to determine if the blogger met the four inclusion criteria. If so, they were added to the list and both their blogrolls and comments were examined to determine other potential members of the network. At the end of the comment crawl, 19 additional blogs were added to the list. 276

Once the comment and blog crawls were complete, the list was pruned utilizing two criteria related to the theoretical construct of participation: at least one interaction with another individual in the community and mutuality of relationships with others in the network. Both Gee (2005) and Wenger (1998) require interaction with others in order for an individual to be considered inside the boundary of the community or affinity space. Comment links are the only way that bloggers can interact directly with other bloggers. Consequently, any blogger that did not make or receive a comment during the study period was excluded from the list. As pointed out by Amin and Roberts (2008), mutual engagement is an important aspect of interaction that supports knowledge generation. For the purposes of this study, we defined mutual engagement as the presence of at least one inlink (blogroll, comment, or Citation) from another blogger and one outlink (blogroll, comment, or Citation) to another blogger. After the network was pruned 99 bloggers remained. 289

Data Collection 301

The posts and comments from each blog were recorded for a 6-month time period. The citation links, blogroll links, and comment links between blogs were used to map relationships between blogs. These relationships were used to create a network map of the bloggers. Not all relationships in the community are reciprocal, so the network map is represented with a directed graph. When available, demographic data were also collected from each individual blog. This demographic data included country of residence, specific subject area of expertise, grade level(s) taught, and gender. 302

Data Analysis

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In this study, we combined structural and contextual data. Then we used cluster analysis to partition the network into groups with similar characteristics. Cluster analysis has been utilized in previous studies of social roles (for example Helms et al. 2006; Moen et al. 2000). Mooi and Sarstedt (2011) recommend that if n clustering variables are chosen, the size of the sample should be at least 2^n . Based on this recommendation, we chose to utilize only six clustering variables.

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One variable was used to identify the length of engagement with other bloggers: length of time blogging. The length of time blogging was defined as the number of months between the first blog post and the end of the study time period. This variable was included in order to help differentiate between groups of peripheral members. Wenger (1998) differentiates between two different types of non-participation: newcomers whose non-participation is a result of their newness to the community and long standing members that either for some reason chooses non-participation as their mode of participation or that are marginalized by the community.

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The remaining five variables concerned the hyperlinks between bloggers in the network. Although these hyperlinks were structural, the different types of links used by various bloggers are also indicative of different behaviors engaged in by bloggers. Someone that frequently cites other blogs helps to distribute knowledge throughout the network. Someone that makes comments on other blogs, however, may serve as an informal mentor to others in the network. By separating different types of links into different variables, we retained the contextual/behavioral meaning of the different types of hyperlinks. The first structural measure used was the number of reciprocal ties between a blogger and others in the network. Two blogs were considered to have a reciprocal tie if they were connected by a bidirectional tie of any type: blogroll, comment, or citation. Relationships take time to maintain. Bloggers with a large number of reciprocal relationships likely invest very little time in each individual relationship. Thus, bloggers with many reciprocal ties likely have a large number of shallow relationships. Two measures were used to measure the public nature of a blogger's participation: Awareness and visibility. Awareness and visibility are two sides of the same coin. Awareness measures the outlinks (either blogroll or Citation) from one blogger to others while visibility measures the inlinks (either blogroll or Citation) to a blogger from others. Individuals with high awareness know a lot about what goes on in the network. These bloggers may be able to help connect individuals to needed resources distributed throughout the network. A blogger with high visibility on the other hand, primarily contributes through the creation of new knowledge. Two final measures were used to determine frequency of interaction with other bloggers. Since interaction is only indicated by comment links, we used comments made and comments received to measure the frequency with which a blogger contacts or is contacted by others in the network.

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All variables were normalized before cluster analysis was performed using the MCLUST program (Fraley et al. 2013) for the R statistical package. MCLUST chooses both the most appropriate clustering method and the most appropriate number of clusters by identifying the model that produces the lowest value of the Bayesian Information Criterion (BIC). In this study, this method was preferable to either k-means or hierarchical clustering since we had no theoretical basis for selecting a number of clusters or an appropriate clustering procedure. Once clusters were identified, specific centrality measures (e.g., degree) of ego networks were computed for each member in the network.

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Results

Cluster Analysis

The diagonal multivariate model with varying volume and equal shape (VEI) and five clusters produced the lowest value of Bayesian Information Criterion (BIC). Bloggers of clusters 1 and 5 had lower average awareness and visibility than bloggers of Clusters 2, 3, or 4 (see Table 1).

Clusters 1 and 5 made and received fewer comments and had fewer reciprocal ties than the other clusters. Bloggers of these two clusters have weaker ties to others. This suggests that bloggers in these two clusters are defined more by their non-participation than their participation. By examining the average time spent blogging of both clusters, it is clear that Cluster 1 is made up of relative newcomers, while the members of Cluster 5 have a longer history of non-participation. This suggests that the two clusters remain on the periphery of the community for different reasons. We have chosen to call members of Cluster 1 “Newbies” and the members of Cluster 5 “Peripheral Members”.

Clusters 3 and 4 had higher visibility, higher awareness, made and received more comments, and had more reciprocal relationships. These two groups represented the full participants. Unlike the members of Cluster 3, the bloggers of Cluster 4 had extremely high visibility and received comments from a larger portion of bloggers. Since Cluster 4 occupied a uniquely visible position amongst the full participants, we chose to refer to them as the “Celebrities”. The members of Cluster 3 were more central than the members of Clusters 1, 2, and 5. For that reason, we chose to call them “Full Participants”.

The members of Cluster 2 had higher awareness and visibility than the peripheral members in Clusters 1 and 5, but lower awareness and visibility than the core members in Clusters 3 and 4. The members of Cluster 2 were not full participants, but they were not fully peripheral either. The members of this cluster seemed to be transitioning from peripheral to full participant, on an inbound trajectory. For this reason, we chose to call this cluster “Inbound Participants”.

Comparisons Among Clusters

For each cluster, we computed the range for the length of time blogging, the number of posts made by the blogger during the observation period, and the number of comments made and received by the blogger (see Table 2).

Table 1 Cluster means

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
	“Newbie”	“Inbound”	“Full Participant”	“Celebrity”	“Peripheral”
	(n=35)	(n=34)	(n=16)	(n=7)	(n=7)
Time Blogging	13	17.59	29.69	34.43	69.14
Community Awareness	4.79	8.43	16.31	24.43	3.23
Community Visibility	1.56	7.63	15.19	45.71	4.23
Comments Made	1.80	3.71	6.81	11.14	2.23
Comments Received	1.40	3.56	5.94	16.43	1.71
Reciprocal ties	1.11	4.23	9.31	22.86	1.57

Table 2 Cluster ranges

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
	“Newbies”	“Inbound Participants”	“Full Participants”	“Celebrities”	“Peripheral Participants”
	(<i>n</i> =35)	(<i>n</i> =34)	(<i>n</i> =16)	(<i>n</i> =7)	(<i>n</i> =7)
Time Blogging	4–39	4–61	9–82	14–35	47–85
Number of posts made	4–162	5–121	26–197	36–290	7–110
Comments Made	0–5	0–11	1–17	3–27	0–5
Comments Received	0–5	0–10	1–12	10–24	0–3

Despite differences in the averages that suggest that Cluster 1, which we identified as the Newbies in the network, there were bloggers in each of Clusters 1–3 that had been blogging less than 6 months. The minimum number of posts is highest for the Celebrities and Full Participants; however, the difference between the minimum and maximum number of posts made by bloggers in the cluster is more than 100 for all five clusters.

Centrality measures were computed for each of the ego networks. The results of these centrality measures were compared across clusters (see Table 3).

On average, the Newbies and Peripheral Participants have a lower indegree and outdegree than the other clusters while Celebrities and Full Participants were higher on Betweenness centrality than the other clusters. Even so, just as we demonstrated with the ranges in Table 2, there is significant variation for ego network structure within each cluster. Since the structural nature of a blogger’s ego networks may influence how an individual’s participation will change over time and how quickly these changes will occur, in the section that follows, we have chosen to highlight the similarities and differences in ego network structure between to individuals from each cluster.

Cluster 1—Newbies

In this cluster, we chose to examine the ego networks of Blogger GV and Blogger GY. Both have expertise in elementary education. At the end of the study time period, Blogger GV had been blogging less than 6 months while Blogger GY had been blogging for almost 2 years. Both bloggers make several posts each month. Although both bloggers had similar posting frequency, the patterns of relationships with other community members are different (see Fig. 1).

Table 3 Cluster means for centrality measures

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
	“Newbie”	“Inbound”	“Full Participant”	“Celebrity”	“Peripheral”
	(<i>n</i> =35)	(<i>n</i> =34)	(<i>n</i> =16)	(<i>n</i> =7)	(<i>n</i> =7)
Indegree	2.74	9.63	17.38	49.86	5.71
Outdegree	5.62	10.23	19.63	29.00	4.43
Betweenness	20.16	36.44	187.24	1098.14	17.06
Out Eigenvector centrality	0.14	0.27	0.49	0.60	0.09
In Eigenvector centrality	0.05	0.21	0.35	0.80	0.12

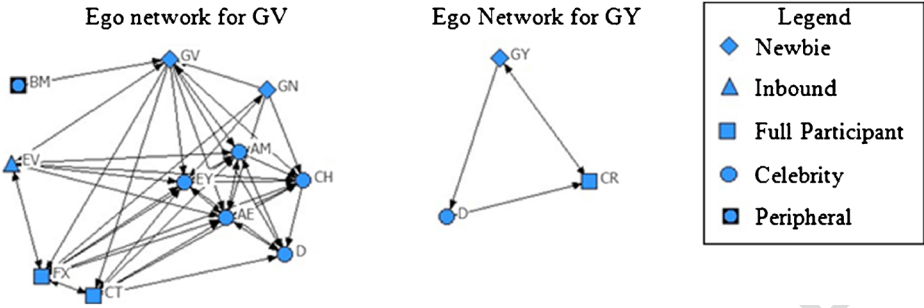


Fig. 1 Comparison of ego networks for Newbie cluster

Blogger GV has an ego network that includes 10 members and is aware of at least one member from each of the five different clusters. Blogger GY has an ego network that includes only two other community members from two different clusters. In addition, GV has reciprocal relationships with both Blogger EV and Blogger AM while Blogger GY only has a single reciprocal relationship with Blogger CR. Blogger GV ranked as more central than Blogger GY on all five measures of centrality.

Cluster 2—Inbound Participants

In this cluster we chose to examine the ego networks of Bloggers GE and GZ. Both are secondary science teachers. By the end of the study, Blogger GE had blogged for fewer than 6 months and blogger EZ had been blogging for close to 2 years. Both posted at least twice a month. Both had three reciprocal connections to other bloggers in the network. While their number of reciprocal relationships was the same, Blogger GE had an ego network that included 28 other bloggers while Blogger EZ only had connections to 13 other bloggers (see Fig. 2).

Both Blogger GE and Blogger EZ had larger networks than either of the Newbie bloggers from Cluster 1. While Blogger GE was more central with regard to outdegree, out eigenvector centrality, and betweenness, she was not more central with regard to indegree and in eigenvector centrality. Although her network was larger, it was primarily because she pursued friendships rather than being pursued by others.

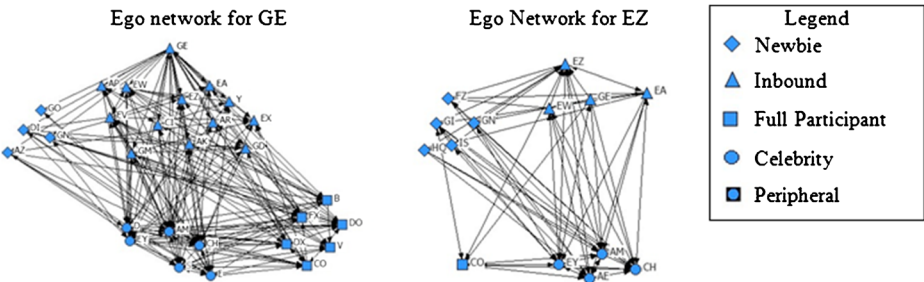


Fig. 2 Comparison of ego networks for the Inbound Cluster

Cluster 3—Full Participants

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For the Full Participant Cluster, we chose to highlight the networks of Blogger CO and Blogger DX. Both are university professors that frequently post about the teaching of college level science courses. At the end of the study, Blogger DX had been blogging for almost 3 years and Blogger CO had been blogging for less than a year. Blogger CO has relationships with 24 other community members and Blogger DX has relationships with 17 related bloggers (see Fig. 3).

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Both Blogger DX and Blogger CO made comments on 13 other blogs within the network. However, Blogger DX only received 4 comments on his blog while Blogger CO received 10 on her blog. Blogger DX ranked as more central than Blogger CO on all five measures of centrality.

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Cluster 4—Celebrities

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Bloggers CH and EY had been blogging for 17 and 16 months respectively at the end of the study. Both teach secondary science courses. Blogger EY is much more prolific than Blogger CH, posting more than 20 times a month. Despite more infrequent posting, Blogger CH has a network that includes 51 other bloggers within the network while Blogger EY has a network that includes 41 bloggers within the network (see Fig. 4).

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Although Blogger CH has higher indegree, eigenvector centrality, and betweenness, he is lower on both outdegree and out eigenvector centrality. During the study, Blogger CH reached out to other bloggers less often than Blogger EY. He infrequently commented or cited others in the network. Despite this, 22 network members cited him and he received comments from 13 others in the network.

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Cluster 5—Peripheral Participants

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Blogger DL is a secondary science teacher turned administrator that had been blogging for almost 7 years at the end of the study. Blogger GB is a current secondary science teacher that had been blogging for more than 5 years at the conclusion of the study. Both have small networks that include bloggers from the Newbie, Celebrity, and Inbound Clusters (see Fig. 5).

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Although both chose not to participate in the network by citing or commenting, they were both prolific posters: often making more than 6 posts per month.

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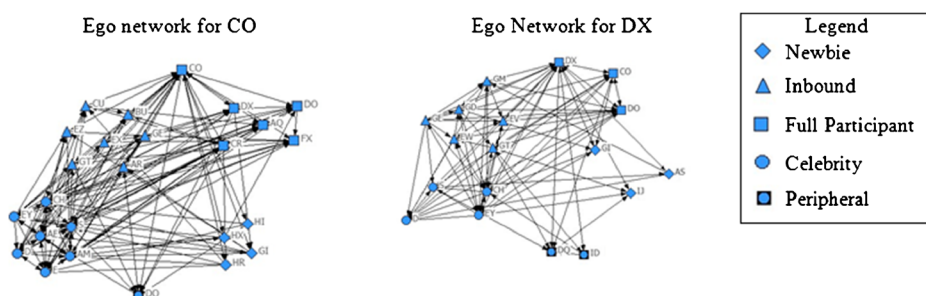


Fig. 3 Comparison of ego networks for the Full Participant Cluster

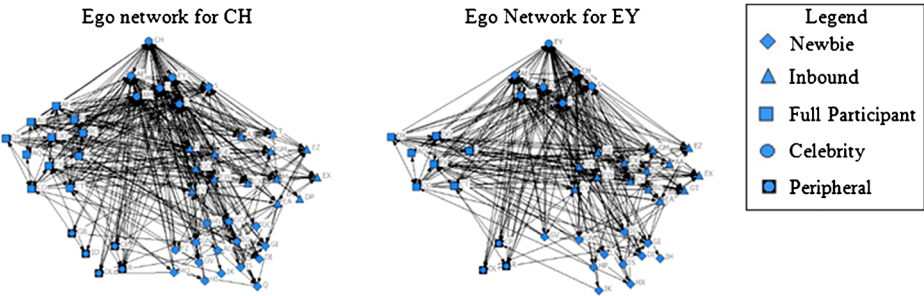


Fig. 4 Comparison of ego networks for the Celebrity Cluster

Discussion and Conclusion

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Contrary to expected results, Newbies aren't necessarily people who have been blogging a short time. Three of the five clusters included bloggers with less than a year's experience blogging. Yet, there were members of the Newbie Cluster with a long history of blogging. For instance, Blogger GY had a longer history of blogging than either of the Celebrities described. Yet, her ego network was smaller and she was less central to the network than either of the Celebrities. The structure of her network seemed more similar to those of the Peripheral Participants than to those of the Inbound Participants. This suggests that Blogger GY's current trajectory will eventually lead to Peripheral rather than Full Participation. This result is interesting because Newbies are typically identified as members with a limited role in the community based on their lack of time interacting with others in the community. This result suggests that Newbies should not be solely identified by length of engagement, but also by the pattern of behaviors indicating inexperience navigating cultural norms that keep them on the periphery of the community interactions.

In the examination of behaviors engaged in by certain bloggers, it became clear that commenting on the blogs of others in the network was one possible way to gain status in the community. For both the Newbies and Inbound Participants we highlighted, the blogger that made more comments on the blogs of others had more reciprocal relationships with other bloggers and was more central in the network. However, it seemed that commenting alone was not sufficient to ensure a quick transition to higher status. Despite making the same number of comments and blogging for a longer period of time, Blogger DX was less central in the network than Blogger CO. This might be explained in part by the fact that Blogger DX wrote only about teaching college level physics. Blogger CO on the other hand wrote about a wider number of topics related to the teaching of science and mathematics. The focused nature of Blogger DX's interest might make his posts interesting to only a small number of bloggers

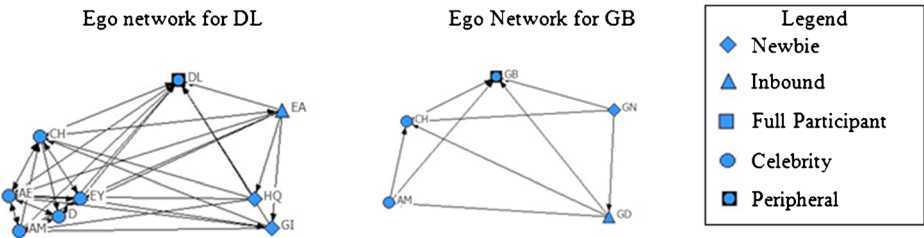


Fig. 5 Comparison of ego networks for the Peripheral Cluster

within the network. A similar result was seen with Blogger CH. He wrote about an innovative way to teach a particular scientific topic on his blog. Others in the network were very interested in the idea and began citing him and commenting on his blog. Celebrity may therefore be related not only to whom you know and how long you have known them, but also to what you contribute. This result fits well with affinity space theory, which emphasizes that there are many ways for an individual to gain status in an affinity space (Gee 2005). In contrast, CoP theory, which is built on the idea of apprenticeship for professional learning suggests that time is the primary route to status in a community. Cross and Prusak (2002) called peripheral bloggers with knowledge that makes them important to the network “peripheral specialists”. They have expertise of interest to the network. If other bloggers in the network recognize this expertise, these individuals could potentially transition from Newbie to Celebrity more quickly than peripheral bloggers without valuable expertise.

In a collaborative learning network, the knowledge constructed by community resides in the collective members and can only be accessed through engagement with others in the community. Engaging with others is how knowledge is generated by the community and gained by individuals within it. Early theorists in the field of collaborative learning focused on participation and interaction as prerequisites for meaningful learning (Johnson and Johnson 1999; Lethinen et al. 1999). Previous research studies have shown that learners occupying a more central position in the network learn more than those on the periphery of the network (Cho et al. 2007). This suggests that a central position in the network is more desirable than a peripheral position. The benefits of centrality do come at a cost. From a social network perspective, larger networks take more time and effort to maintain. Classroom teachers may lack time to build and maintain large online networks (Instone 2005). In addition, large networks are often highly interconnected and provide redundant information to the individual.

It is therefore encouraging that some research has shown that lurking on the periphery of a network still allows learning (Beaudoin 2002). For example, Dennen (2008) found that students in an online course felt that they learned from both posting and reading messages. Both the theory of Legitimate Peripheral Participation (Lave and Wenger 1991) from CoPs and the theory of participation in affinity spaces (Gee 2005) recognize that being less than a full participant is often the result of a conscious choice. Individuals may choose not to engage in full participation for a variety of reasons including lack of time and lack of interest in core discussions. These choices do not reduce the benefit that an individual may enjoy as a result of the partial participation. Although individuals can still benefit from peripheral participation in a network, extremely small networks, like the one of Blogger GY can create difficulties for individuals. Blogger GY has a single reciprocal contact within the community. If that individual was to leave the network, Blogger GY could find herself again on the outside of the network boundary.

Wenger (1998) uses the concept of boundary encounters to describe how to make connections or to gain entrance into various CoPs. He describes three types of encounters: 1) boundary practices; 2) overlaps; and 3) peripheries. Of particular interest is the periphery of a practice as this is neither inside nor outside of a practice and creates an opening for interaction and exchange of practice. Because the engagement is less structured at the periphery, Wenger (1998) sees this as “a very fertile area for change” (p. 118). It is at the peripheries where there are multiple overlaps and connections and the “possibilities for participation offered to outsiders or newcomers” (p. 118) thus sustaining and perpetuating the community of practice. Peripheral participants may connect the community to other communities and provide novel ideas and/or other perspectives for more central members.

In this way, peripheral participation not only benefits the individual, but also the network as a whole. Because there is value to both central and peripheral participation, it is important for collaborative learning platforms to provide avenues both for participation and for lurking.

Significance and Areas for Future Research

There are a number of different benefits of participation of teachers in online networks. Online social relationships may be particularly important to teachers in some types of schools or those that teach particular subjects (Fulton et al. 2005; Kardos and Johnson 2010) that may have difficulty finding other teachers to collaborate with that are in close geographic proximity. Blogs, and other social networking tools, can provide opportunities for collaboration by reducing the importance of geographic proximity in collaborative relationships. In addition, these virtual networks are highly transportable. As teachers change schools or districts, their virtual networks may travel with them in a way that more traditional networks do not. Virtual spaces also allow for what Little (1990) characterized as deprivatized practice. This deprivatization enables teachers to collaborate with others in the profession. Participation in such networks is, as Little (1990) suggests, a way to overcome the isolation and autonomy of the profession and offers a space for teachers to examine and thus potentially change their practice. These spaces also provide researchers with unprecedented access to both how teachers work and the impact of collaboration on that work. Little (2002) describes the value of observing these communities and their interactions.

“Looking close up at the teacher interaction, across a range of settings-both in formally organized professional development and in naturally occurring school workplace contexts-will further open the black box of professional community and show when and how it is conducive, or not, to the transformation of teaching.” (p. 940)

Virtual networks give researchers a chance to observe how teachers create and share knowledge about the practice of teaching. The communications between participants can be analyzed (Nakajima et al. 2005) in order to allow researchers to observe how educational reform actually occurs. These online networks have the potential to support collaborative learning and ongoing professional growth. Identifying the attributes or practices that support this participation is only the first step in this process. Next we have to examine the nature of the interactions for additional evidence to determine the potential knowledge generation occurring in these virtual spaces. Examining the nature of the interactions, the substance of the conversations, and the essence of the collaborative nature of the interactions will help us better understand the real potential of these professional networks.

Limitations and Future Research

The primary limitation of the data is the limited scope of the data collection. While examination of interactions between bloggers does provide a picture of relationships and interactions within the network, the picture is an incomplete one. Not all relationships and interactions are necessarily captured on the blogs of participants. Several of the bloggers described interacting with other members either face-to-face or using another social networking tool. Surveying bloggers about these other connections and interactions would create a more complete understanding of the relationships. While survey methodology would allow us to include relationships and interactions that take place in other contexts, the information about the relationships and interactions would be much less detailed. The rich historical record available with online interactions gives a far more contextualized and less biased view of

the relationship between an individual blogger and other bloggers than either interview or survey data. Kozinets (2010) identifies several difficulties that researchers face in conducting interviews with individuals online. In addition, this type of data can be extremely time consuming to collect making them impractical tools for the study of large virtual networks. By combining structural and contextual/behavioral information via cluster analysis, we retain some of the qualitative information that would be lost via a strictly structural approach.

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