Analysing Interactions in a Teacher Network Forum: A Sociometric Approach

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Abstract

This article presents the sociometric analysis of the interactions in a forum of a social network created for the professional development of Portuguese-speaking teachers. The main goal of the forum, which was titled Stricto Sensu, was to discuss the educational value of programmes that joined the distance learning model in Brazil. The empirical study focused on the sociometric analysis of the social interactions that take place in asynchronous online environments. This approach, according to literature, allows for new means to observe, analyse, and interpret the reality of a new social paradigm. This type of analysis tries to understand the relationship established between the different actors, seeking to verify if the roles they play in both the access to information and the construction of shared knowledge. The data collected allow the researchers to deduce that the indicators used in the analysis are important for understanding and intervening in the dynamics and functioning of the network to propose improvements in its structure and organisation. In the specific case of the aforementioned discussion forum, the results of the sociometric analysis of the perceived interactions were not surprising, considering that the nature of the topic did not demand deep reflection to contribute to the debate. (Keywords: teacher networks, forum interactions, sociometric analysis, collaborative learning, e-moderator)

Web 2.0, or the Social Web, brings multiple possibilities for the socialisation of individuals. This form of socialisation happens in different ways, including through sharing photos, music, and interactions in discussion groups, via the many applications available in cyberspace called social networks or virtual communities.

Some studies have proved that these spaces are mostly informal and, in addition to socialising, have the potential to be educational because learning happens in a social network (Lisbôa & Coutinho, 2011). The use of social networks is common in the teaching and learning process as a complement to face-to-face teaching, in distance education, or even in the professional development of teachers (Pinto, 2009), as these professionals face the current demands of society and feel the need to keep up to date and continue lifelong learning through interaction and knowledge sharing.

In this context, Senge (1990) emphasises that knowledge is seen as a social construct and that learning organisation necessarily involves the search for knowledge. Within this social construct, individuals are encouraged and feel the need to continuously develop "their ability to create the results they truly desire, with high standards of reasoning, where collective aspiration is set free, and people learn continuously in group" (Senge, 1990, p. 11).

We created the Teachers in the Digital Age (PROEDI) social network (www.proedi.ning.com) to promote the professional growth of a group of Portuguese-speaking teachers who sought to share their knowledge and experience in informal learning environments. To promote collaborative learning among the social network members, the researchers and the community members launched several forums.

Like Clark (2006), we believe that information is the basic principle that flows across networks and therefore must be considered its supreme good. Thus, social network analysis (SNA) is set up as a resource, or even a strategy, that facilitates an explanation of the communication flows, enabling an understanding of the relationships made and an identification of any bottlenecks. The identification and understanding of these factors may offer possibilities to interfere in its dynamics (i.e., proposing actions for improvement in its organisation and functioning), especially those related to the role of the e-moderator in the whole process.

In the literature, SNA is widely used to analyse interactions in social networks for the study of a diversity of different and heterogeneous contexts, such as political organizations, enterprises, and marketing and health studies (Eveland & Kleinman, 2013; Pinto & Junqueira, 2008; Raeymaeckers, 2013; Zelner et al., 2012). Regarding educational research, a systematic search of academic databases, such as Scopus and Ebsco, verified that social network analysis was mainly used as a strategy to analyse the processes of knowledge construction and collaboration in online and distance education (Jablokow & Vercellone-Smith, 2011; Jimoyiannis & Angelaina, 2012; MacKellar, 2012; Rice Doran, Doran, & Mazur, 2011; Romero-Moreno & Lucena, 2010; Silva & Figueira, 2012; Thornton & Leahy,

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2012). The position a member occupies in a sociogram allows researchers to understand the individual processes of knowledge acquisition (Oshima, Oshima and Matsuzawa, 2012) or even the construction of the so called "social capital" inside the community (Coromina, Coenders, Ferligoj & Guia, 2011; Recuero & Zago, 2009; Recuero, 2006; Rice Doran, Doran & Mazur, 2011). However, we did not find reports of the use of SNA to study the processes of e-moderation and shared leadership inside a social network, so we believe our study is a contribution to the state of the art.

Considering the above, we formulated a research question to guide the empirical study: How does the SNA analysis clarify the understanding of the dynamics of communication inside a social network, particularly those related to the e-moderation process? Can we improve organisation and functioning of a virtual community based on the SNA analysis?

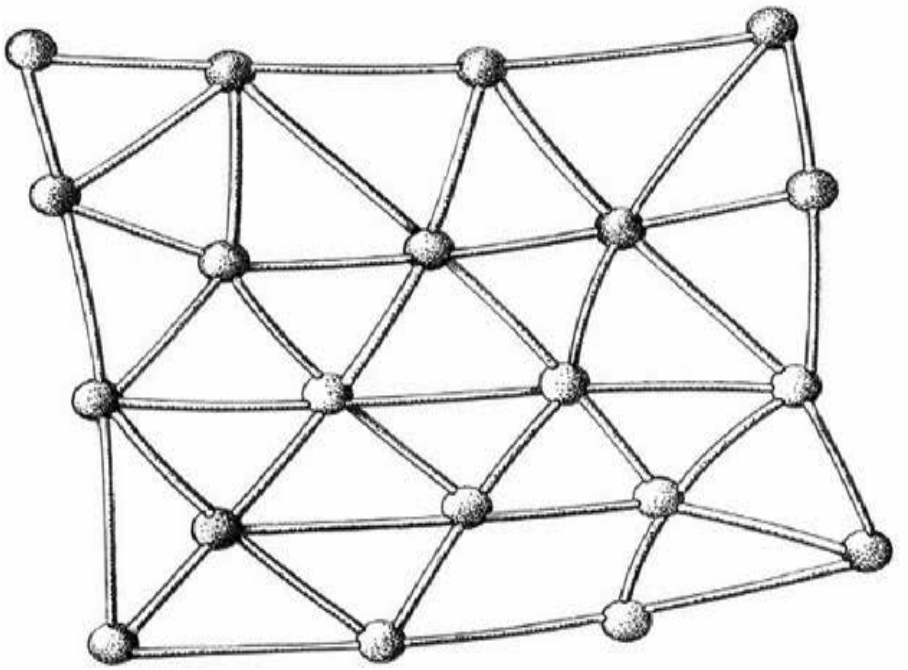

Figure 1. Distributed networks (Baran's diagram, 1964).

Review of Literature

Defining Social Networks

Based on the studies of Castells (2000), Levy (2003), Capra (2002), Barabási (2002), and Franco (2008a), we can characterise social networks as a set of relationships or connections where messages flow (nodes). Graphically, we can say that these connections can be represented by edges, and the nodes can be represented by vertices (Lisbôa & Coutinho, 2010). Thus, from the existing connections in relation to the nodes, we can identify whether an organisation can be considered a network (see Figure 1).

The figure illustrates how people are linked to each other without the predominant figure of a coordinator. Each node is connected to several of its neighbouring nodes, and there are many degrees of distribution, as each node has several possible routes to send data. If a route or neighbouring node is destroyed, another path will be available (Baran, 1964). Therefore, we believe that the nodes and connections are constituent elements of the network, in which the nodes are represented by people and the connections are the relationships established between these individuals through various interactions: "When this happens, we say that a connection has been established" (Franco, 2008b, p. 113).

In a successful network, information must flow in a decentralised manner for members to feel free to participate and be respected in their cultural diversity. The environment must be democratic for the exercise of shared leadership (Dias, 2008).

Social Networks and the Construction of Knowledge

According to Levy (1998), cyberspace represents a new medium in which everyone can contribute to its growth and development through the production and dissemination of information and knowledge. This growth is associated with cyberculture, as it is the manifestation of the practices, cultures, and opinions of several users who attend the virtual environments. It is in this context of collaboration that social networks arise, supported by interconnection and collective intelligence. Interconnection is related to the different forms of interaction available online, and collective intelligence is the result of online collaboration, as all cybernauts are potential producers of knowledge (Harasim, 2012).

In addition, interconnection contains various forms of interaction and collective intelligence that represent the result of the collaborative process that is possible in cyberspace, given that everyone can be producer of knowledge. Indeed, according to Levy (2003), the possibility of interaction within the community is related to the same theme, which makes virtual communities a space conducive to the spread of cyberculture. Thus, we can say that virtual communities represent the interest of a certain group of people in sharing common information, which makes them a location for the most diverse artistic and cultural manifestations, promoting approximation and uniting individuals by the most diverse interests (Lisbôa & Coutinho, 2011).

Sociometric Analysis

In the literature, several techniques have been used in SNA. In the specific case of the present study, we will focus on the sociometric analysis. According to Varanda (2000), this analysis has been considered by a large number of theorists to be the new social paradigm due to its original way of observing, analysing, and interpreting reality. Overall, this kind of analysis tries to understand the

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relationship between the different actors, seeking to verify if the roles that they occupy may influence access to information, knowledge, and the construction of knowledge (Clark, 2006).

The SNA aims to characterise the organizational structure of a social group, representing visually the existing individual connections to find out if there is reciprocity in the communication flows (unidirectional or bidirectional), if the group is cohesive, who the members are who exercise leadership, and how the group functions as a whole (Newman, 1999). By building graphical representations of networks, the researcher is able to understand how they are organised and the types of existing interactions, as well as their joints, providing them with the authority to propose actions for improvement or reorganisation of its structure (Kauchakje & Delazari, 2007). According to Scott (2004), some of the essential characteristics of a network can be analysed through matrixes. In this design, the graph theory describes the networks rigorously and carefully, describing them through master data that can be translated into concepts and/or theorems and stored and/or related in specific computer programs, allowing a much easier and objective approach. However, for a more detailed and fruitful network, an analysis of its main indicators is required, including: (a) network density, (b) degree of centrality, (c) centralization index, (d) intermediation degree, and (e) closeness degree.

Method

The present study followed a qualitative mainstream line, as its main purpose was to analyse the interactions established between the actors of the network as well as the behaviour and position of each member (Hirschi, 2009). To this end, we used a number of techniques related to SNA that allowed us to represent the interactions and relationships between the actors, not only by means of graphic representation, but also through some indicators that provided inputs to explain the network's functioning (Hirschi, 2009).

In general terms, the SNA aims to describe and represent the interactions of network elements in order to help researchers understand the behaviour and attitudes of the actors participating in the discussion forum. According to Wellman (2001), the SNA is a very effective method through which to understand the organisation and arrangement of members in a social network, which in the specific case of our study was the social network Teachers in the Digital Age (PROEDI).

The PROEDI was created on the Ning social software tool and has been online since January 2011. Its main objective is to explore new approaches to the training and professional development of teachers that emerge from the context of the paradigm known as Web 2.0. This online environment has been used in various contexts, including as an informal learning environment and as a complement to the activities of formal teacher training programmes.

The present study involved a group of teachers from the Federal University of Maranhão (UFMA) and the State University of Piauí (UESPI), who were participating in the programme Promoting the Use of ICT in Undergraduate Courses, which was directed at teachers of public universities whose projects had been approved by the Foundation for Co-ordination and Improvement of Higher Education Personnel (CAPES).

This course focused on offering a theoretical and practical basis to promote integration between the classroom education and distance education system (b-learning) in higher education institutions (IES) of the federal and state sphere, and also those that integrate the Open University of Brazil (OUB) system. In addition, the programme aimed to promote the development of digital literacy and to develop participants' desire and need to use information and communication technology (ICT) in the teaching and learning process.

With these goals in mind, the instructor presented the PROEDI social network, requested the adherence of all teachers, and familiarised them with an environment focused on the training of teachers, as most of them had not participated in this kind of network or virtual community in the past. The forum titled Stricto Sensu, which is the focus of this article, started from the initiative of a participant who wanted to listen to the group's opinions on Stricto Sensu programmes in Brazil and its adherence to b-learning. This proposal was not planned in the programme, nor was it directly connected to the training activities mentioned above.

Data Collection and Analysis

To collect data, we used a survey with a main objective of characterising the sample. This instrument is associated with the Ning social network and serves as a criterion to access it.

For the structural analysis of the network, we used direct observation, which was reported in literature as the most adequate technique to study the interactions between the members of a restricted group (Bernard, Kilworth, & Sailer, 1990; Freeman & Michaelson, 1988, 1989; Freeman & Romney, 1987; Killworth & Bernard, 1976; Lemieux & Ouimet, 2008). We used the software Ucinet to analyse the indicators (density, degree of centrality, index of centrality, intermediation, and closeness) and Netdraw to create graphical representations of interactions (Borgatti, 2002).

Sample

Participants in the PROEDI network created the Stricto Sensu forum. Fifty members (29 females and 21 males) participated in this forum. Regarding age, 28% of the participants were 26–30 years old (14 members), 20% were 36–40 years old (10), 16% were 31–35 years old (8), 14% were 46–50 years old (7), 8% were 51–55 (4), 6% were 41–45 years old (3), 6% were 56–60 years old (3), and 1 member did not report. With respect to employment, the majority (31 members) were teachers. As for the social networks used, Facebook (22) took the lead, in addition to PROEDI. Concerning the participation in virtual communities, an overwhelming majority (35) indicated that they had not participated in any virtual community. Furthermore, 28 members reported a basic knowledge in ICT training, 11 reported an average knowledge, 6 claimed

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to possess no knowledge, 4 claimed to have advanced knowledge in ICT, and 1 person did not report.

Results

In this section, we present the results of the sociometric analysis of the perceived interactions in the discussion forum Stricto Sensu according to the set of indicators previously mentioned.

Density

Most theorists who discuss the subject consider the analysis of the frequency of the interactions as one of the most basic features within a sociometric analysis. Fifty members participated in this network, which presented 115 links. To provide a better visualisation of the generated discussions on the theme of discussion forum, Figure 2 presents the graph of interactions.

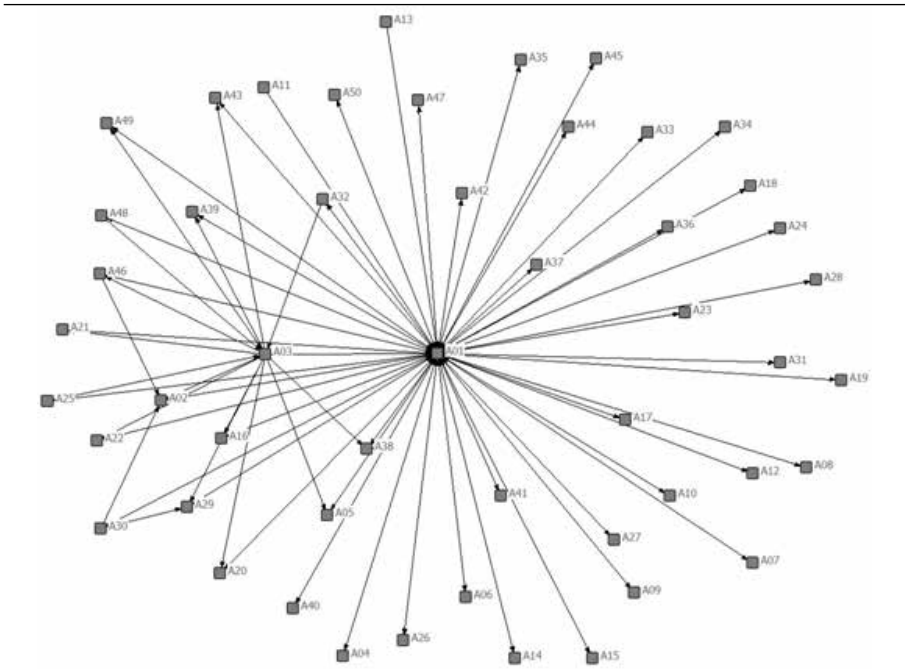

Figure 2. Analysis of interactions.

Each point of the sociogram represents a member of the network. The lines that have no arrow at the end represent a unidirectional relationship, meaning that the member received an invitation to participate in the discussion but did not interact (see A11 or A13). When the lines have arrows at the extremities, this member received and sent messages (A49–A43). There is no loose node in this sociogram, as all members connected at least once with the e-moderator (A03).

A global glance at the sociogram immediately reveals that there was little interaction between the members. The great majority are not loose nodes (i.e., A07, A09, A43) because the actor A01 maintains contact with them and is responsible for establishing and sharing information. A larger interaction volume can be identified on the left side of the graph, where the nodes A03 and A01 preserve the cohesion and connection within the group.

According to the graph, it is evident that the network is not very dense. However, to calculate the density of the network, we need to know the number of possible relationships, with reference to the number of participants in this forum (50), which we have already called nodes. According to Lemieux and Ouimet (2008), we calculate the number of possible relationships by multiplying the total number of nodes (NTN) by the total number of nodes minus 1 (NTN-1), as follows: RP = NTN x (NTN -1).

We calculated that, in theory, the network could have 2,450 possible relations (RP = 50 x [50-1] = 50 x 49 = 2450). However, it was only possible to envision 115 relationships. Therefore, the density is the ratio of the number of existing relations and the possible relations: D = RE/RP x 100 (i.e., D = [115/2450] x 100 = 4.69%). Based on this result, we can say that the ties are mostly considered weak, as the relationships observed are dispersed, without any closeness, and they do not converge to achieve a greater engagement of the group (Granovetter, 1973; Wellman, 1997).

Degree of Centrality

The degree centrality on a network is an indicator that measures the number of direct links that each actor or member has within the network. Depending on the direction of flow, it can be classified as a degree of input or output. The degree of input can be defined as the sum of the interactions that the other members establish with a particular actor. However, the degree of output works conversely: It is the number of interactions that the actor has with other members (Clark, 2006; Velázquez & Aguilar, 2005).

The Ucinet presents the actors organised by their level of centrality through the following columns: (a) outDegree (output degree), (b) InDegree (input degree), (c) NrmOutDeg (standard output degree), and (d) NrmInDeg (standard input degree). The last two columns show the percentage representation of their degrees. Accordingly, Table 1 illustrates that the actor A01 has a higher level of centrality reflected in an input degree of 48 (this number means that potentially A01 was available to 48 of the other members of the community), which corresponds to a standard input degree of 97.9%. This was followed by A03, who had an input degree of 5 and a standard input degree of 10.2%. Less significant, the actor A02 possessed an input degree of 4 and a standard input degree of 8.16%. On The nodes A11 and A13 do not have input degrees, as none of the members established communication with these actors.

Centralization Index

The centralization index is the indicator that defines whether an actor is the cen-

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Table 1. Degree of Centrality

ID	OutDegree	InDegree	NrmOutDegree	NrmInDegree
A01	47.000	48.000	95.918	97.959
A03	14.000	5.000	28.571	10.204
A32	2.000	1.000	4.082	2.041
A49	2.000	2.000	4.082	4.082
A25	2.000	2.000	4.082	4.082
A46	2.000	2.000	4.082	4.082
A02	1.000	4.000	2.041	8.163
A08	1.000	1.000	2.041	2.041
A04	1.000	1.000	2.041	2.041
A11	1.000	0.000	2.041	0.000
A06	1.000	1.000	2.041	2.041
A10	1.000	1.000	2.041	2.041
A14	1.000	1.000	2.041	2.041
A15	1.000	1.000	2.041	2.041
A16	1.000	2.000	2.041	4.082
A17	1.000	1.000	2.041	2.041
A18	1.000	1.000	2.041	2.041
A19	1.000	1.000	2.041	2.041
A20	1.000	2.000	2.041	4.082
A09	1.000	1.000	2.041	2.041
A22	1.000	2.000	2.041	4.082
A23	1.000	1.000	2.041	2.041
A12	1.000	1.000	2.041	2.041
A13	1.000	0.000	2.041	0.000
A26	1.000	1.000	2.041	2.041
A27	1.000	1.000	2.041	2.041
A28	1.000	1.000	2.041	2.041
A29	1.000	3.000	2.041	6.122
A05	1.000	2.000	2.041	4.082
A31	1.000	1.000	2.041	2.041
A07	1.000	1.000	2.041	2.041
A33	1.000	1.000	2.041	2.041
A34	1.000	1.000	2.041	2.041
A35	1.000	1.000	2.041	2.041
A36	1.000	1.000	2.041	2.041
A37	1.000	1.000	2.041	2.041
A38	1.000	2.000	2.041	4.082
A39	1.000	2.000	2.041	4.082
A40	1.000	1.000	2.041	2.041
A41	1.000	1.000	2.041	2.041
A42	1.000	1.000	2.041	2.041
A43	1.000	2.000	2.041	4.082
A44	1.000	1.000	2.041	2.041
A45	1.000	1.000	2.041	2.041
A21	1.000	2.000	2.041	4.082
A47	1.000	1.000	2.041	2.041
A48	1.000	1.000	2.041	2.041
A24	1.000	1.000	2.041	2.041
A50	1.000	1.000	2.041	2.041

tral element of a network—if, apart from stopping the flow of communication, the actor is also the communication point between the other members of the network (Velázquez & Aguilar, 2005). In general, we noticed that the network is highly centralised, as the data displayed by the software confirm that the network in its entirety has an output centralisation degree (Outdegree) of 95.026% and an input centralisation degree (Indegree) of 97.151%.

Intermediation Degree

The intermediation degree is an indicator that allows the researcher to identify the position that the actors have in the network. To theorists such as Varanda (2000); Flap, Bulder, and Volker (1998); and Velázquez and Aguilar (2005), among others, the higher the intermediation degree, the greater the likelihood that the individuals have access to information and, consequently, have more control of communication compared to members who have a peripheral, marginal participation, or even compared to those who are isolated (loose nodes).

From the data, we recognised that the actor A01 has the greatest degree of intermediation with 2204.5, which expresses the number of peers with which the actor can connect. This represents a total percentage of 93.72% (degree of normalised intermediation). Next, A03 has a degree of normalised intermediation of 2.7%, and finally the node A02 represents the others who have no degree of intermediation.

Closeness Degree

The closeness degree is the "capacity of a node to connect to all the actors of a network" (Velázquez & Aguilar, 2005, p. 24). It is the indicator that specifies the closeness degrees of an author in relation to others on the network. According to Fidalgo and Freitas (2011), "the geodesic distance—that is, the shortest route—between pairs of actors is one of the most widely used measures of closeness" (p. 1396). When we observe a network and verify that a given node has a higher closeness degree, this means that

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Table 2. Intermediation Degree

ID	Betweeness	nBetweeness
A01	2204.500	93.729
A03	64.500	2.742
A02	0.000	0.000

it exceeds the rest in its ability to connect to other actors in the network. In the sociogram, those are the nodes that are closer to the center of the network (see Figure 2).

Table 2 (p. 146) shows two types of closeness (incloseness and outcloseness), which refer to the input closeness degree and the output closeness degree. In addition, it illustrates the deviation degree of input and output of each member of the network (infarness and outfarness). In our analysis, we will take only the closeness degree and the deviation degree as references. Thus, we can see that A01 has a greater closeness degree with a value of 98.000, followed by node A03 with a value of 52.688. In a more extreme position, the actors A11 and A13 have a lower closeness degree, assuming a value of 2.000.

Supported by the literature on the subject, (Borgatti, Everett, & Freeman, 2002), it is apparent that the actors A01 and A03 have a greater power of influence when imposing their opinions and interfering directly over the other elements. In contrast, nodes A11 and A13 have the lowest closeness degree and therefore have the greatest deviation degree. This means that, in theory, these actors are more autonomous regarding their choices and behaviours (Freeman, 1978).

Conclusions

The study proves that the SNA is an effective methodology with which to analyse the existing interactions between people within a specific group, particularly social networks and virtual communities.

The data allowed us to deduce that the indicators we used in our analysis are of great value in understanding and intervening in the dynamics of the functioning of the network to propose improvements to its structure. In our study, they served as a thermometer to measure the engagement of the informal group of teachers on the PROEDI social network and to analyse the type of relationships that were established as well as ascertain who the leaders were inside the community. In the specific case of this forum, which was launched to listen to the members' opinion about a specific distance education program in Brazil, the data we obtained were not surprising, considering that the nature of the subject did not require deep reflection to contribute to the debate.

However, it is clear that the actors who present a greater centralization index and hold more information also have the opportunity to receive more information and therefore are the most popular and influential in the network. In the forum we analysed, these actors were the creators of the discussion forum and the e-moderator.

On the other hand, we see that the network is highly centralised, as essentially two actors hold the largest number of possibilities to interact with others. This is apparent in the graph, which shows that the two actors who participate most frequently have an important function: to keep any element from being a loose node (i.e., a person who does not maintain communication with any element of the network). However, even though they were not active members in this discussion forum, those members had a peripheral participation, which, according to Wenger (1988), enables learning. We believe that mere participation and reading some contributions on the discussion forums provide opportunities to learn. However, in the current context in which we live, where collaborative learning is a subject much in vogue, there was a lack of member engagement and participation and, consequently, contribution to the growth of the group. As Ally (2004, p.24) remarked, it is necessary for each member to be "able to interact within their context to customize information and construct their own meaning." We expect teachers to gradually realise the importance of participation in these new informal learning environments, where, in addition to gathering information, they can exchange ideas, collaborate, and customise their formative courses while increasing their digital literacy.

On the other hand, lessons learned from our study show that SNA is a powerful tool to inform social network leaders/administrators, as it functions as a kind of a mirror that reflects the organization of the whole community. Through the analysis of the visual sociogram as well as the numerical indicators, one can gather useful data in order to implement strategies that allow information to flow horizontally inside the community, allowing the group to become more and more cohesive.

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