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A Social Network Analysis Comparison of an Experienced and a Novice Instructor in Online Teaching

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Abstract

The most productive learning experience for students whether online or in face-to-face classes can often be the interaction among students and with an instructor. Online teaching and Social Network Analysis (SNA) offer the opportunity to examine intellectual social networking and strategies that promotes student interaction which can enhance learning.

This study focuses on two online courses in which we used Social Network Analysis (SNA) techniques to evaluate and compare student and instructor interactions of two online courses (Lesley University, Cambridge, MA and Instituto Piaget, Lisbon, Portugal). One course was taught by an experienced online instructor and the other by an instructor new to the online teaching format.

We describe and present some of the main features of SNA such as degree of participation, density of interaction, linkage, formation of subsets, distribution of centrality among the participants as well as network patterns.

Although the countries and content of the courses were different, SNA allowed us to make comparisons using objective statistical methods. We found that the instructional approach has a clear effect on interactions. In addition, we noted that under some instructional circumstances a multi-star pattern of interaction was created which is an undocumented SNA pattern. We also observed that SNA can be useful in studying online course interactions leading to enhanced learning.

Resumo

Uma das experiências de aprendizagem mais produtivas para os estudantes, quer em aulas presenciais quer online, pode ser, frequentemente, a interacção entre estudantes e com o instrutor. O ensino online e a Análise de Redes Sociais (ARS) oferecem uma oportunidade de observar as redes sociais académicas e as estratégias que promovem a interacção entre os estudantes com vista a melhorar a aprendizagem.

Este estudo foca-se em dois cursos online nos quais foram usadas técnicas de Análise de Redes Sociais (ARS) para avaliar e comparar as interacções dos estudantes e dos instrutores nos dois cursos (Lesley University, Cambridge, MA e Instituto Piaget, Lisboa, Portugal). Um dos cursos foi leccionado por um instrutor experiente e o outro por um instrutor novo no formato de ensino online.

Descrevemos e apresentamos algumas das principais análises da ARS como o grau de participação, a densidade de interacção, grau de ligação, formação de subconjuntos, distribuição de centralidade entre os participantes, bem como padrões de rede."

Embora os países e conteúdo dos cursos fossem diferentes, a ARS permitiu-nos fazer comparações utilizando métodos estatísticos objectivos. Aferimos que a metodologia de ensino tem um efeito claro sobre interacções. Além disso, observamos que em algumas circunstâncias de ensino um padrão multi-estrela de interacção foi criado, e que este padrão não foi ainda documentado. Também se observou que a ARS pode ser útil no estudo das interacções de cursos online o que poderá conduzir a uma melhoria da aprendizagem.

Keywords: discussion forums, distance learning, e-learning, online interaction, social network analysis

Introduction

According to Anderson and Elloumi (2004) online Interaction in a distance education learning context can have several functions in the educational process. These include those listed by Sims in 1999 "as allowing

for learner control, facilitating program adaptation based on learner input, allowing various forms of participation and communication, and acting as an aid to meaningful learning.” (Idem, p. 43) as well as Vygotsky’s theory of Zone of Proximal Development (ZPD). Peer interaction in learning supports current educational perspective about the importance of interactions with peers and instructors (Baran & Correia, 2009; Barnett-Queen, Blair, & Merrick, 2005; Ferguson, 2010; Hylton, 2007; Murphy, Mahoney, Chen, Mendoza-Diaz, & Yang, 2005; Oliver, Osborne, & Brady, 2009; Thormann, 2008).

Online discussion boards provide an ideal venue to examine interactions among learners and with instructors. Social Network Analysis (SNA) provides a window through which to look at online environments by “(...) teasing out the prominent patterns in such networks, tracing the flow of information through them, and discovering what effects these relations and networks have on people and organizations.” (Zaphiris & Ang, 2009, p. 231) SNA also provides a visual analysis of the networks and allows us a better understanding of all stakeholders in the process of learning and teaching in online environments (Freeman, 2004) Moreover, educators who use a constructivist approach rely on interactions among students and students and instructor to enhance learning (Bronack, Riedl, & Tashner, 2006; Chang & Smith, 2008; Maor, 2003; Murphy et al., 2005) “The ability to view social graph structure and community evolution is crucial to successful facilitation and serves as an early indicator of the success of a learning activity design as well as information about student participation and potential performance.” (Bakharia, Heathcote, & Dawson, 2009, p. 125)

This data mining technique of SNA tries to identify trends in patterns from data, that do not usually surface otherwise. (Campbell, DeBlois, & Oblinger, 2007) SNA “(...) has established itself as a useful approach to study the interconnectivity of individual or collective actors in social processes such as communication flows or decision-making situations.” (Hirschi, 2010, p. 2) Through these techniques we can see the actors’ locations in the overall network (Hanneman & Riddle, 2005). Because of the central importance of interaction in online teaching we have chosen to use SNA as a tool to study student interaction and suggest why specific patterns emerge.

The main objectives of the study were to:

- Conduct a preliminary study using SNA to examine two courses. One taught by an experienced online instructor (Lesley University, Cambridge, MA) and the other by an instructor new to the online teaching format (Instituto Piaget, Almada, Portugal).
- Determine the degree of participation, interaction, linkage, formation of subsets, distribution of centrality among the actors of the networks and identify the principle participants;
- Observe the location of the different actors (students and instructor) and assess their position in the networks forums;
- Discover patterns of relationships created within the forums by the actors;
- Compare the two courses and discuss the instructional approaches that might have led to the observed intellectual social network results.

Methodology

Participants and setting

This preliminary study was conducted using two online courses, one taught by an experienced online instructor at Lesley University (LU), Cambridge, MA with Blackboard and the other taught by an instructor new to online teaching at Instituto Piaget (IP), Almada, Portugal using Moodle. The LU course had 13 students and one instructor (total of 14 participants). The IP course had 16 students and one instructor (total of 17 participants). The LU course lasted for eight weeks, October through December 2010, while the IP course lasted for 14 weeks, September 2010 through January 2011.

Aside from one, all LU students were enrolled in an online M.Ed. Technology in Education Program. They were all educators in K-12 schools throughout the United States. Most of the students had taken seven online courses prior to enrolling in this one titled “21st Century Teaching: Supporting All Learners on the Ability Spectrum.”

The IP students were from two Campuses of IP (Almada and Mirandela) and were enrolled in the last year of a Communication Sciences university degree. The course was “Institutional Communication”. Ten students from Almada Campus had prior experience attending one online course and the remaining six students from Mirandela had no online course experience.

Teaching Practices

The LU instructor uses a constructivist approach to learning and as a part of this, implements a number of strategies to extend student interactions. She believes strongly in the importance of peer interaction and having students participate in discussions as a way to enhance learning. Teaching online since 1996 has

provided the opportunity to develop various ways to increase student participation. A number of techniques were used to build an online community during the course. The first assignment involved having students introduce themselves in the context of the course content. They were also encouraged to provide personal information. Students were required to ask questions and post responses. This served as a way for students to get to know each other. Small group Skype meetings were held early in the course to discuss an assignment. This offered students the chance to hear each other's voices and get to know each other better. After modelling facilitation the LU instructor had small groups of students (2 to 3) facilitating discussions. A Coffee Shop and Teacher's Room forum were set up. The former was for informal communications about any topic that interested the students from photos of trips to non-course related professional issues. The Teacher's Room was for questions and comments about course assignments. Overall the LU instructor promoted interaction among and with students by making students feel safe to speak up and having most forums remain content oriented.

The IP Instructor used a mixed approach to learning, doing a transposition of some face-to-face techniques to the online environment and using some of Moodle features to promote student independence, greater responsibility and ownership for their learning through the use of Information and Communication Technologies (ICT). These techniques were incorporated into a grading structure with many kinds of activities such as book reviews, tests, PowerPoint presentations, etc. The non-forum activities had a greater weight, than participation in the forums, in the final grade. Because of the grading structure the full potential of forums as an interaction tool was not met and may have led to low student participation. Also the fact that some of the students did not have prior experience in online courses may have contributed to less interaction in the forums. Some students were, throughout the course, in the process of adaptation to the online environment which may help to explain their behaviour.

Forum descriptions

The LU forums that we included in the analysis focused on discussions of how to use technology with and for individuals with special needs except for the *Coffee Shop* and *Teacher's Room*. The Coffee Shop was an optional space where students "can 'talk' about personal issues, such as photos from trips, events, hobbies ,chat or just relax and get to know each other." The Teacher's Room was a place to "...share course related questions, ideas and respond to questions that your classmates pose about the course material." Both of these non-assignment forums facilitated community building.

Nine of the 11 LU forums involved a specific assignment some of which were multi-stepped (#1 – and #3 - #9). Forum one involved having students introduce themselves and get acquainted through comments and questions to each other. Forum two did not require interaction since the assignment was to learn and use APA standards. Forum three revolved around finding out what kind of special services and technology were available in their home school or district. Student interaction for this forum was conducted in small Skype group meetings. Forum four had students gather resources about a specific topic relating to special education and technology. They also had to develop a brochure, manual or website for their own communities. They were required to comment on each other's assignments. For forum five students were each assigned a video relating to some aspect of technology use for individuals with special needs. Students reported on their video and then discussed various aspects of the videos. Forum six included using accessibility software and discussing the pros and cons. Forum seven addressed implementation of Universal Design for Learning (UDL) and National Instructional Materials Accessibility Standard (NIMAS). Students discussed their postings. In Forum eight students examined and discussed the accessibility of their school district's websites. The ninth and final forum served as a culminating project. Students were required to write an article for publication about a course related topic. All but two (#2 and #3) of the assignment forums required some minimum amount of interaction among students.

In most discussion assignments students were required to make comments and/or questions directed to at least two classmates' and respond to all classmates' comments/questions. Students received credit for each assignment's required interactions (25 % of the grade). The instructor modelled appropriate interactions and posted guidelines so students would understand their responsibilities. In all cases students were encouraged to do more than the minimum. In addition, in forums #5 through #9 small groups of students were required to take the role of student moderators (Thormann, 2008). Rather than having the instructor as the only participant to read and benefit from what students submitted for assignments the LU instructor had students post all their assignments on the forums. Most assignments were structured so that the resulting student submission would be unique. This allowed students to learn from each other as well as from the instructor.

Figure 1 shows a screenshot of the instructor's view of five of the eleven forums in the LU course.

Display Order	Forum	Total Posts	Unread Posts	Total Participants
1	The Coffee Shop This forum is a place we can "talk" about personal issues... like photos from trips, events, hobbies, chat or just relax and get to know each other.	33	0	5
2	Teacher's Room This is where you can share course related questions, ideas and respond to questions that your classmates pose about the course material.	112	0	14
3	Weeks 1 & 2 Assignment #1a- Introduction and #1b Discussion Purpose of Assignments #1a & b: Share past and current experiences with individuals with special needs. Start the process of establishing an online community and become familiar with class participants' experiences and expertise. Due Date #1a-11/1 Due Date #1b-11/8	162	0	14
4	Week 1 Assignment #2 - APA Purpose of Assignment #2: To learn elements of appropriate APA use and citation of material from other sources. Due Date: #2- 11/1	15	0	13
5	Weeks 2 & 3 #3a Field-Based Research and #3b Discussion (Siena Conference) Purpose of Assignment #3a: To develop an understanding of challenges from a teacher's or administrator's perspective and experience on the	18	0	12

Figure 1. Blackboard screen of LU course forums

The participation in all of the five IP forums was mandatory, but the student's only participated in three. The instructor participated in all the forums clarifying some points and asking students directly about some of their postings. A portion of their grade (10 % of the entire course) depended on interactions. The main purpose of the forums was to promote debate about the course content.

The activity of each forum had a theme drawn from the syllabus of the course; the first one provided the students with some texts about 'persuasion' to reflect on. They were asked to also give their opinion about persuasion techniques. In the second forum the students had to reflect about propaganda techniques and were encouraged to exchange resources about this subject (files, pictures, links from web pages, etc.) that they found during their research. In the third forum students were required to provide their opinion/reflection about rumours and gossip and provide some examples that they had found in newspapers. There were two mandatory forums that students did not participate. One required them to watch some BBC videos about the history of persuasion and comment on them. This forum was the last one in the course. The other forum that they did not participate in was called "*Help Forum*" that was created so students could share their concerns and ask questions about technical issues.

Figure 2 shows a screenshot of the list of the forums in the IP course. The list includes two types of forums: *General Forums (Fóruns gerais)* and the *Learning Forums (Fóruns de aprendizagem)*. The first type had two forums, one in which only the instructor could post announcements which was titled *News Space (Espaço notícias)*. The second forum was the *Help Forum (Fórum de Ajuda)* described above).

The screenshot shows a Moodle forum interface. At the top, there is a header for 'PIAGET ONLINE' with the year '11' and 'Ano lectivo 2010/2011'. Below this, there are navigation links and a search bar. The main content is divided into two sections: 'Fóruns gerais' and 'Fóruns de aprendizagem'.

Fórum	Descrição	Temas	Subscrito
Espaço de Notícias	Notícias gerais e anúncios	13	Sim
Fórum de Ajuda	Aqui poderá esclarecer as suas dúvidas	1	<input type="button" value="Sim"/>

Secção	Fórum	Descrição	Temas	Subscrito
1	Persuasão	A partir da leitura dos textos sobre persuasão participe neste fórum com a sua opinião sobre os mesmos.	2	Sim
2	Fórum sobre Propaganda	Este fórum destina-se ao debate de ideias sobre o que é a propaganda e os diferentes tipos de propaganda. Os alunos podem aproveitar para partilhar recursos (através do upload de ficheiros, de links ou outras informações).	1	<input type="button" value="Sim"/>
7	Fórum sobre boatos e rumores	Neste fórum os estudantes os estudantes devem trocar opiniões e exemplos sobre boatos e rumores	3	<input type="button" value="Sim"/>
10	Fórum BBC	Este fórum destina-se à troca de opiniões e comentários sobre os vídeos realizados pela BBC sobre persuasão.	0	<input type="button" value="Não"/>

Figure 2. Moodle screen of IP course forums

Data analysis

The *Social Networks Adapting Pedagogical Practice* (SNAPP) application (Bakharia & Dawson, 2009) was used to extract data from the forums of the online courses (by exporting the .vna format files). The extracted data was analyzed by using UCINET software (Borgatti, Everett, & Freeman, 1999) and Netdraw (Borgatti, 2002) was used for network visualization.

The SNAPP application was created as part of *Seeing' networks: Visualizing and evaluating student learning networks project*. This project was financed by the Australian Council for Learning and Teaching with the goal of developing ICT for data visualization resources. (Wollongon, 2009). According to the SNAPP developers: "Activation of the SNAPP tool results in the in-site embedding of a social network visualization directly below the threaded forum display. Social network diagrams provide an aggregate visual representation of all interactions that have occurred between participants. SNAPP allows the user to interact with the social graph to uncover any emerging patterns." (Bakharia, Heathcote, & Dawson, 2009, p. 50)

Ucinet is a mathematical tool specifically developed for SNA that allows the creation of indicators that help explain a network's structure, as a whole and/or subsets. Its' major function is the elaboration and manipulation of adjacency matrices and it is a package of applications for SNA which includes Netdraw, a network visualization tool.

Netdraw also works directly with adjacency matrices which means it can work with actors and attributes. This software allows the visualization of graphs in two dimensions.

SNA techniques were applied to the eleven forums of the LU course and the three forums of the IP course in which there was student participation. The following measures of Freeman's centrality were analyzed: degree, closeness and betweenness. We also measured density, number of cliques, inclusiveness, and identified the principle participants of the networks as well as patterns of relationship. A detailed description of the SNA numerical analysis that underlies the measures that we present in this study can be found in research work of Anderson, Wasserman & Crouch (1999) and Wasserman & Faust (1994).

After analyzing the different SNA measures we compared and discussed the results of the two courses and tried to establish a relation between the instructional approaches of the instructors and intellectual social network results that were observed.

Research Limitations

The differences between the American and Portuguese higher education systems created some difficulties in making comparisons. The small number of students enrolled in each course, the differing number of forums as well as the small number of forums in the IP course, were issues that were taken into account. The differing content and context were also factors that were considered when examining the results of this research.

Despite these limitations, SNA allowed us to draw comparisons using objective statistical methods and provided some insight into how online classroom strategies and design can be examined to help shape student outcomes.

Findings

Degree of Participation

In the LU course the participation in the 11 forums varied from 5 actors in the *Coffee Shop* to 14 in the majority of the forums. All 13 students participated in all but two of them as well as the instructor. (The exceptions were the 2nd and 3rd forums - in the 2nd the instructor didn't participate because the discussion was not required or necessary and Skype was used in the 3rd). In the IP course there were 16 students and an instructor and participation varied from 8 (in the last forum) to 12 (in the 1st). The instructor was present in all of the three active forums. Some of the students did not participate in any of the forums and as mentioned previously in two of the five IP forums there was no participation at all.

Table 1: Number of participants in the forums of the two courses and their mean

Forums	LU Course	IP course
	Actors	
Coffee Shop	5	-
Teacher's Room	14	-
1st	14	12
2nd	13	11
3rd	12	8
4th	14	-
5th	14	-
6th	14	-
7th	14	-
8th	14	-
9th	14	-
Mean	12,8	10,3

Inclusiveness

The network inclusiveness index is the proportion of actors of a network that have interacted (that have initiated and/or received interactions) with other actors. "(...) the inclusiveness of a graph is the total number of points minus the number of isolated points." (Scott, 2000, p. 70)

Regarding the inclusiveness index (Figure 3), we found that most of the forums of the LU course had very high values with scores of 100 %. These scores may indicate that in the forums, surrounding and non-segregated relationships were established i.e. everyone interacted. In addition students needed to be

inclusive to earn full credit for the discussion portion of the assignments. The only exception was observed in the *Coffee Shop* with a 36 % Inclusiveness Index which may be due to the fact that the participation in this forum was not mandatory. The remaining forums that were below 100 % (#2 and #3), only required that assignments be posted. For #3 a discussion about the assignment took place in small groups using Skype. This was done early in the course to create a stronger community and thus increase student interaction around learning objectives.

In the IP course, although the participation in all the forums was mandatory, only a maximum of 66 % of the students interacted.

	1st forum	2nd forum	3rd forum	4th forum	5th forum	6th forum	7th forum	8th forum	9th forum	Coffee Shop	Teacher's Room
Inclusion Index LU course	100%	93%	86%	100%	100%	100%	100%	100%	100%	36%	100%
Inclusion Index IP course	66%	61%	44%								

Figure 3. Percentage of Inclusiveness of the two courses

We also observed that in the majority of the forums of the LU course there were no isolated actors (with exception of the 2nd and 3rd forums which did not require interaction). This means that all the participants interacted with and/or received interactions from the others. In the IP course there were occasional isolated actors.

Density

The density “(...) describes the overall linkage between network members.” (Müller-Prothmann, 2007, p. 225) Density allows us to gauge the speed of dissemination of information among actors of the network and the extent to which actors have a high degree of social capital and / or social constraint. (Hanneman & Riddle, 2005) According to Lin (1999) social capital relates to the investment that individuals make to gain access to embedded resources through social relations. The main purpose is to “enhance expected returns of instrumental or expressive actions.” (p. 39) In contrast we may think of social constraint as not having access (or having reduced access) to embedded resources because of the kind/number of interactions and position in the network that individuals may have.

The values observed in the forums with required participation of LU course (Figure 4) ranged from 34 % to 51 % in the measure of density/talk (the interactions between the network participants) and from 0.43 to 1.25 in the measure of density/strength (total number of interactions among the network participants). The lower figures indicate a low connectivity between participants and they were observed in the 4th and 9th forums while the higher values were observed in the 1st and 7th forums. The *Coffee Shop* shows the highest degree of density/strength which may indicate that when actors voluntarily participate in a discussion they are more motivated.

As for the IP course values observed (Figure 4) were low and ranged from 14 % to 19 % in the measure of density/ talk and from 0.13 to 0.20 in the measure of density/strength. Although the values were not as low as in the LU course the average indicates a lower connectivity between the participants in the forums.

The meaning of these values in both courses is addressed in the discussion section of this paper.

	1st forum	2nd forum	3rd forum	4th forum	5th forum	6th forum	7th forum	8th forum	9th forum	Coffee Shop	Teacher's Room
LU Course talk	0,51	0,01	0,03	0,34	0,36	0,38	0,43	0,35	0,34	0,50	0,20
LU Course strength	0,76	0,01	0,03	0,46	0,43	0,47	0,43	0,52	0,45	1,25	0,54
IP Course talk	0,19	0,14	0,18								
IP Course strength	0,13	0,14	0,20								

Figure 4. Density/average Matrix Value of the forums of the two courses

Cliques

The cliques are subsets (subgroups) of the network. These subsets exist because the actors that are part of them are linked up more frequently and thus create more intense and closer relationships than other members of the network. For some reason they have reached out or have been contacted by other actors of the network and as result create a subset. The minimum number of actors that can form a clique is 2 and “Formally, a clique is the maximum number of actors who have all possible ties present among themselves.” (Hanneman & Riddle, 2005, p. 80)

In the LU course the 1st forum (total of 45 cliques) was the one with the largest number of subsets and the 7th forum (total of 32 cliques) had the biggest subset of actors (one clique of five actors). The highest number of two and three actors' cliques was observed in the 1st and 6th forums. Of a total of 217 cliques in the LU course the instructor was present in 126.

The results point to a large number of subsets created within the networks of this study. The number of

cliques created also reveals that there were many interactions but in small subsets of the networks.

The number of cliques observed in the IP course was low. There were a total of six subsets in the 1st forum, three in the 2nd and one in the 3rd forum (Figure 5). The highest number of cliques of two actors was five and there was only one subset of three actors. As in the LU course the instructor was present in the majority of the subsets of the required participation forums (of a total of 10 cliques the instructor was present in 7). There was not much interaction in groups as reflected in the low number of cliques observed.

	cliques of 2 actors		cliques of 3 actors		cliques of 4 actors		cliques of 5 actors	
	LU Course	IP Course	LU Course	IP Course	LU Course	IP Course	LU Course	IP Course
1st Forum	17	5	17	1	11		0	
2nd forum	1	3	0	0	0		0	
3rd forum	1	1	0	0	0		0	
4th forum	15		13		0		0	
5th forum	16		11		0		0	
6th forum	22		13		0		0	
7th forum	16		12		3		1	
8th forum	14		8		0		0	
9th forum	16		10		0		0	
Coffee Shop	2		1		0		0	
Teacher's Room	4		1		0		0	

Figure 5. Number of cliques of the forums of the two courses

Centrality

“The measure of Centrality Degree allows us to gauge which actors occupy central positions in a network and have potential in terms of 'power' within that network. The actors who have more connections to other actors within the network can gain an advantageous position because they have alternative ways to meet their needs and because they depend less on other actors.” (Fidalgo & Freitas, 2011, p. 1394) “The Centrality Degree is an indicator of expertise and power of network members. It measures the incoming and outgoing connections held by an individual network member.” (Müller-Prothmann, 2007, p. 226) For instance more access means that if a student needs information or resources it is easier for him to reach those things if he occupies a central position in the network where he has many connections and is in the “path” between other actors.

Freeman's Centrality Degree is the most used centrality measure of Ucinet and allows us to verify the distribution of the degree of centrality among the actors of a network. This property can be very important “(...) because it describes whether the population is homogeneous or heterogeneous in structural positions.” (Hanneman & Riddle, 2005, p. 65) In a homogeneous population the actors occupy similar positions in the network while in a heterogeneous one or more actors occupy a central position while the remaining participants interact less.

In the type of connections established between the actors of a network we can distinguish between OutDegree (when an actor connects with others) from InDegree (when an actor is chosen by others) for the relation of Talk (the interactions between the network participants) and the relation of Strength (total number of interactions among the network participants).

With regard to Freeman's degree of centrality measures (Figure 6) the mean values of OutDegree and InDegree for the LU course, in the forums with required participation, the values ranged from 33.5 % (4th forum) to 50.5 % (1st forum) in the talk relation and from 7.5 (8th forum) to 17.4 (7th forum) in the strength relation. The gap between the lowest and highest value is understandably large due to the nature of the forums but the highest value of centrality measure in the talk relation means that only half of the network participants chose to connect with others and did it with a low number of interactions (17.4 in the strength relation).

For the IP course and regarding this same measure the mean values of OutDegree and InDegree ranged from 13.6 % (2nd forum) to 18.9 % (1st forum) in the talk relation and from 9.8 (3rd forum) to 13.6 (2nd forum) in the strength relation. The gap between the values observed is not too large but not even 1/5 of the network participants connected with others and those who did exchanged an even lower number of interactions (13.6 in the strength relation).

We also analyzed the Centrality Degree of each actor and we found that in the LU course the instructor had the highest values of OutDegree (from 23.0 % to 100 %) and InDegree (from 38.4 % to 84.6 %) in all the forums in which she participated (as said before she did not participate in the 2nd and 3rd forums).

In the IP course the instructor had the highest values of OutDegree ranging from 40 % to 85.7 % (talk relation) and from 40 to 50 (strength relation). Regarding the InDegree, different students in the three forums had the highest values and those ranged from 30 % to 63.6 % (talk relation) and from 30 to 36.36 (strength relation).

	Mean NrmOutDeg	Mean NrmInDeg	Mean NrmOutDeg	Mean NrmInDeg	Mean NrmOutDeg	Mean NrmInDeg	Mean NrmOutDeg	Mean NrmInDeg
	LU course: talk		LU course: strength		IP Course: talk		IP Course: strength	
1st forum	50,5%	50,5%	15,2	15,2	18,9%	18,9%	11	11
2nd forum	1,3%	1,3%	1,3	1,3	13,6%	13,6%	13,6	13,6
3rd forum	3,0%	3,0%	3	3	17,9%	17,9%	9,8	9,8
4th forum	33,5%	33,5%	15,4	15,4				
5th forum	37,9%	37,9%	15,6	15,6				
6th forum	37,0%	37,0%	15,6	15,6				
7th forum	43,4%	43,4%	17,4	17,4				
8th forum	35,2%	35,2%	7,5	7,5				
9th forum	34,1%	34,1%	8,9	8,9				
Coffee Shop	50,0%	50,0%	25	25				
Teacher's Room	19,8%	19,8%	6,7	6,7				

Figure 6. Normalized OutDegree and InDegree (talk and strength relation) of the forums of the two courses

Betweenness

The measure of betweenness was developed by Linton Freeman^[1] as a way to analyze binary relations established in the networks. "(...) betweenness centrality views an actor as being in a favoured position to the extent that the actor falls on the geodesic paths between other pairs of actors in the network." (Hanneman & Riddle, 2005, p. 67) John Scott (2000) adds that "The betweenness of a point measures the extent to which an agent can play the part of a 'broker' or 'gatekeeper' with a potential for control over others." (p. 86)

The betweenness mean in the seven forums requiring interaction of the LU course ranged from 4% in the 1st forum to 13 % in the *Coffee Shop* while in the IP course the values ranged from 2 % in the 3rd forum to 13 % in the 2nd one (Figure 7). From the standpoint of structural constraint these values indicate that in these networks there was not a lot of 'power.' The actor with the highest values of betweenness in the LU course was the instructor (in five of the nine required forums in which she participated). In the Coffee Shop the highest value of betweenness belonged to a student closely followed by the instructor who had the highest values in the Teacher's Room. In the IP course the instructor had the highest values in two of the three forums.

	LU Course: Mean nBetweenness	IP Course: Mean nBetweenness
1st forum	4%	9%
2nd forum	0%	13%
3rd forum	0%	2%
4th forum	6%	
5th forum	6%	
6th forum	6%	
7th forum	5%	
8th forum	7%	
9th forum	6%	
Coffee Shop	13%	
Teacher's Room	9%	

Figure 7. Normalized betweenness centrality of the forums of the two courses

Despite the betweenness values the networks centralization^[2] values (Figure 8) were, on average, relatively low in more than half of the forums for both courses. This makes sense because most connections can be made in these networks without the aid of any intermediary – this means that there is not a lot of betweenness.

	LU Course	IP Course
	Network Centralization Index	
1st forum	28,8%	41,3%
2nd forum	0,0%	23,3%
3rd forum	1,8%	11,9%
4th forum	51,2%	
5th forum	29,4%	
6th forum	13,2%	
7th forum	8,8%	
8th forum	16,6%	
9th forum	41,4%	
Coffee Shop	30,2%	
Teacher's Room	40,7%	

Figure 8. Network Centralization Index of the forums of the two courses

Closeness

The shortest route (geodesic distance) between pairs of actors is one of the most widely used measures of closeness. This measure emphasizes the distance between an actor and all other actors in the network. "The average geodesic distance for an actor to all others, the variation in these distances, and the number of geodesic distances to other actors may all describe important similarities and differences between actors in how and how closely they are connected to their entire population." (Hanneman & Riddle, 2005, p. 57) According to these authors, actors who can reach others with short path lengths or who are more reachable by other actors have favoured positions which provide a structural advantage that can be translated into power. "This logic of structural advantage underlies approaches that emphasize the distribution of closeness and distance as a source of power." (Idem, p.62) Closeness centrality can be divided, in directed data, into inCloseness (distance from the other actors of the network to one actor) and outCloseness (distance from one actor to the other actors of the network).

Regarding the LU course the mean values of inCloseness and outCloseness for forums with required interactions ranged from 56 % in the 8th forum to 63 % in the 7th (Figure 9). The 2nd and the 3rd forums had the lowest values but, as mentioned before, the participation was not appropriate. The instructor had the higher values of inCloseness and outCloseness in four of the seven forums in which she participated (inCloseness ranged from 50 % to 100 % and outCloseness from 56.2 % to 100 %) In the other three forums students had the higher values.

For this measure in the IP course, values of inCloseness ranged from 17 % (3rd forum) to 29 % (1st forum) while values of outCloseness ranged from 18 % (2nd forum) to 21 % (3rd forum). The instructor had the higher values of outCloseness (from 21.7 % in the 2nd forum to 50% in the last one) sharing one of these values with a student in the 2nd forum. Regarding the values of inCloseness the higher values belonged to students and were from 31.8 % (3rd forum) to 42.3 % (1st forum).

	LU Course		IP Course	
	inCloseness	outCloseness	inCloseness	outCloseness
1st forum	68%	68%	29%	25%
2nd forum	0%	0,0	20%	18%
3rd forum	9%	9%	17%	21%
4th forum	59%	60%		
5th forum	60%	61%		
6th forum	60%	60%		
7th forum	63%	63%		
8th forum	56%	56%		
9th forum	59%	58%		
Coffee Shop	59%	46%		
Teacher's Room	39%	21%		

Figure 9. Mean of Closeness Centrality of the forums of the two courses

Network patterns

One of the advantages of using SNA techniques is that they can provide a visual approach of the networks

through graphs. Those graphs are sociograms that can help understand a network from a holistic perspective through the knowledge of the localization of its participants and the connections they establish.

The most frequent network pattern found in all the forums of the two courses was the 'star pattern' (Figures 10 and Figure 11). In this type of pattern and according to Hanneman & Riddle (2005) the actor who takes the central position in the 'star' creates more opportunities and options than others. His structural position allows him, for example, greater exchange and sharing of resources.

In the LU course the instructor (green) was the most prominent actor at the center of the 'star' in four of the seven forums. In the rest of the LU forums students had central positions (Figure 10).

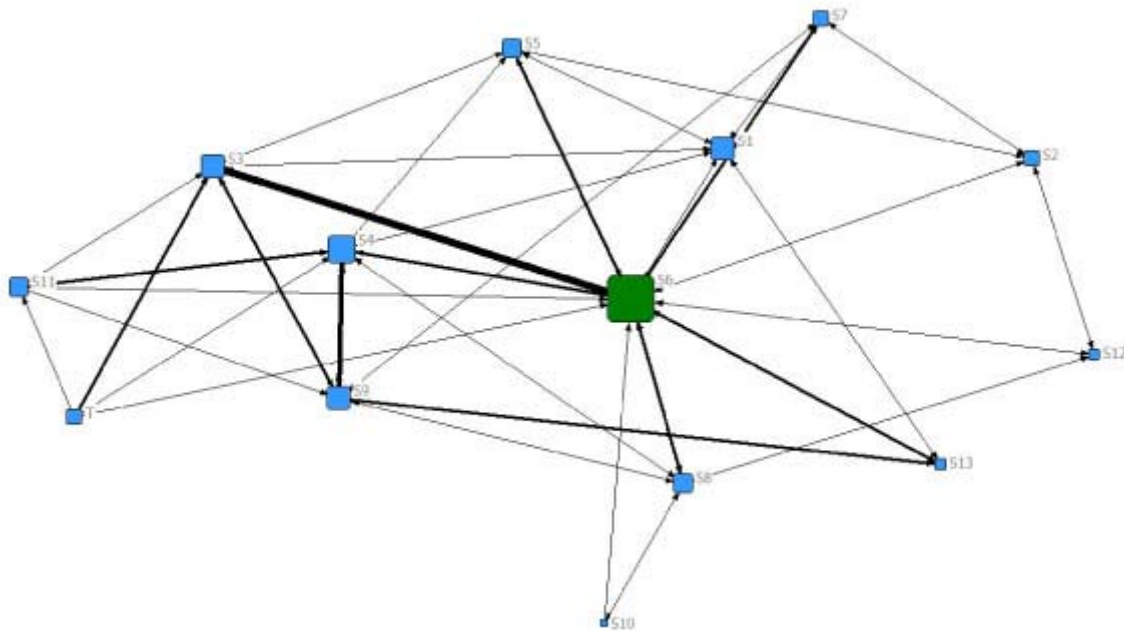


Figure 10. 9th Forum of LU Course: Example of the 'Star Network Pattern' with a student in the central position

In the IP course the instructor (blue) was at the centre of the two forums that had a star network pattern.

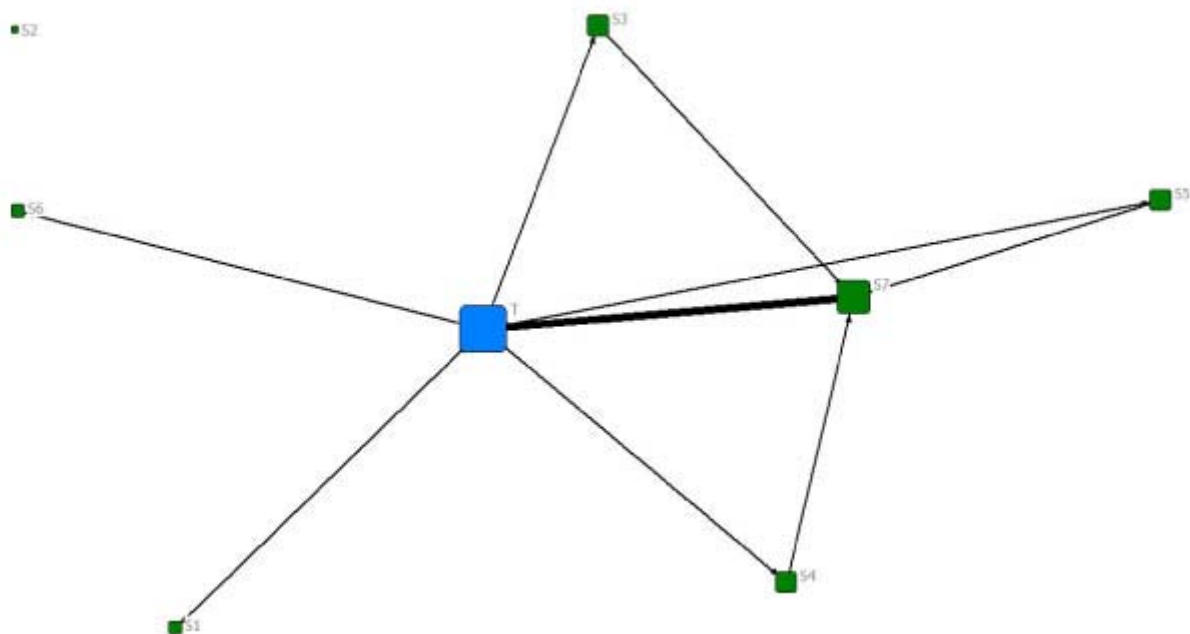


Figure 11. 3rd Forum of IP Course: example of the 'Star network Pattern' with the instructor (T) in the central position

Although in both courses the central position in the star pattern was occupied by a single actor (the instructor in the majority), it can be seen in both Figures 10 and Figure 11 that there are additional smaller stars in the network. These multi-star patterns can be seen throughout most of the other forums in which there was interaction. The centrality measures support the existences of more than one actor with a prominent role in the network.

Discussion

Course comparisons

From the analysis of the forums of the two courses in this preliminary study the most interesting results we have observed are:

Although participation was mandatory in the majority of the forums in the LU and IP courses, students in the Portuguese course only participated in 3 of the 5 forums. In the LU course students participated in all of the mandatory forums which explains the inclusiveness values found (100 %). In the IP course the fact that the students' assessment depended on their interaction in the forums did not lead to greater participation (maximum of 66% of inclusiveness). The IP instructor only informed the students of the grades that they earned in the forums towards the end of the course and kept the forums open during the entire course which may help to explain the low and late participation of the students. We know the participation of students was late because Moodle provides daily reports on participation and most of the postings were in the last days of the course.

The LU instructor graded each week's assignment by awarding points. Twenty-five percent of the points for each assignment were specifically allocated to substantive participation in a discussion. Students were required to post comments/questions to a minimum of number of classmates' work. It was also mandatory for students to respond to comments/questions posted about their work.

The IP instructor created fewer forums than the LU instructor because the grading structure included many other kinds of assessment activities which had greater weight in the final grade. The fact that the IP grading structure did not encourage ongoing discussions about the themes also may help to explain the lower inclusiveness index. We think these low values may be due to giving grades at the end of the course and that there were not clear consequences for non-participation (or late participation). By the time that most of the students participated the themes had been addressed in assignments several weeks before.

The values of inclusiveness can also help us explain the values of closeness of the networks because it provides us with the degree of participation in those networks. In the LU course the values of closeness were higher than in the IP course. The results may have been different because the LU instructor gave students guidelines for participation as well as the reasons stated in the previous paragraphs.

SNA measures

SNA provides quantitative measures and thus interpretation of high and low values is dependent on the context which is what we attempt to describe in this discussion.

With regard to density the LU course forum networks had the higher values which can be explained by the greater participation of the students and from which we can conclude that there was a higher connectivity between the participants of this course. According to Lin's (1999) definition of social capital we can say that in the LU course the students had more social capital in the forums than the students from the IP course because they invested more in social relations through interactions.

We think one of the reasons for higher connectivity for LU students may be due to the requirements, the immediate reward of the grade system and the LU instructor's efforts to build community. An analysis of the students' postings, show us that some of them posted more than what was required. We suggest they may have found the discussions intrinsically rewarding which may account for this behaviour.

In the IP course the lower density also led to fewer interactions among the students who did participate. From all the possible interactions in the networks only about 20% were achieved while in the LU course some forums exhibited values of 50%. The number of times that the IP instructor participated in the forums as well as the reasons stated above for the inclusiveness measures may help to explain these values.

Because in both courses there were not many students enrolled (13 in the LU course and 16 in the IP course) the formation of subsets with a high number of participants was less probable and that is what was observed. In the LU course the number of cliques in the forums was much higher when compared to the IP course and in both courses the instructor was present in the majority of the subsets. If we take into account the overlap of participants in the cliques the numbers are even lower than shown in Figure 6.

Regarding the degree of centrality of networks of the forums the values of normalized OutDegree and InDegree in the strength relation were lower than in the talk relation in both courses which means that the actors who occupied the most central positions in the networks did it without needing to do or to get a great number of interactions.

The centrality values in the IP course were lower than in the LU course which can be explain by the lower values of interaction from the actors. Since the instructors had the higher values of centrality regarding the

Outdegree of the talk and strength relation (while students had the higher values of InDegree) we can say that although there was not much interaction in the networks the instructors interacted more with students than the reverse.

In the LU course there was a greater distribution between instructor and students in regard to who had the highest values of centrality (both in the talk and strength relation and in OutDegree and InDegree values). These values mean that the population of the network forums in LU course was more homogeneous than in the IP course regarding the distribution of 'power'. The incoming and outgoing connections were made by different actors in several of the seven forums.

Nevertheless in both courses the instructor was one of the principle participants in the majority of the forums having also higher values of Betweenness (although overall the values were low) which means that in most of the cases they were in a favoured position to play the role of 'brokers' or 'gatekeepers' and have potential for control over the other network members. Because in the LU course the networks were more homogeneous this favoured position was also occupied, in some forums, by students. In the IP course students occupied a central position in only one forum. The low values of Betweenness can also be explained, as we have said before, by the fact that most connections could be made without the aid of any intermediary. We believe that the networks small size also contribute to explain these values.

Regarding the centralization index which reflects the degree of connectivity to the network from the principle participants, in the assessed forums there was a wide variation of the values in both courses. We do not have a clear explanation why there was a variation.

In the IP course the forum with the highest values of centralization and Betweenness was the one where students were asked to not only post but also to exchange resources (files, pictures, web pages links, etc.). These high values belonged to the students and not to the instructor.

As to the LU course the higher values of centralization were in the 4th forum and belonged to the instructor. We think that this may have occurred because the instructor intervened when the student moderators did not interact sufficiently during the week they chose to moderate.

The fact that the LU and IP course instructors assumed, in the majority of the forums, a central position resulted in their establishing more connections and more connections being established with them by others. Instructors are responsible for ensuring that students learn through interacting with other students as well as with the instructor and the available resources. As a result the instructors took the role of guiding the discussions.

Regarding the patterns of relationships we found multi-stars within most of the network forums. This is especially true in the LU course where the networks were more homogenous. The LU instructor consciously shared the facilitator role. In the IP course the instructor was consistently in the center of the star because she did not ask students to moderate or act as facilitators. We have not read about the multi-star network patterns in the SNA literature and would encourage others to investigate this.

Instructional approaches

One major focus of the LU instructor has been to increase substantive student participation. Through 15 years of experience in online teaching the LU instructor has experimented with various strategies to promote discussion that would enhance learning. Some of these strategies are describe early in the article. The IP instructor, who has taught online for just over 3 years, is still in an early stage. This stage often consists in a transposition of an instructor centered face-to-face model to the online environment (Conrad, 2004; McQuiggan, 2007). The SNA results may be impacted by the instructional approach because the results depend on interactions (and kinds of interactions) from the network participants.

Conclusion

SNA shows that the specific instructional approach used in our research produces different results in the interactions between the actors of an academic online course network. Although, in our study, the patterns of relationships in both courses showed a similar configuration, the principle actors responsible for the values found were not the same in LU and IP course. The student-centred model of LU course promoted the homogeneity of the networks allowing students to share some centrality and 'power' with the instructor. In the IP course, the SNA data illustrated an instructor-centred model in an online environment.

While the IP instructor's goal was to encourage student independence, greater responsibility and ownership, this was not achieved in the forums. However some students were able to reach this through the other assignments.

In the early stage of the online teaching instructors may be more focused on adapting and/or designing and delivering a course rather than being focused on students' interactions. An experienced instructor has

potentially resolved many design and delivery issues. If the instructor values interaction as a fundamental learning process, she can invest in promoting these interactions. But because each content area and group of students have different needs and characteristics the instructor needs to adapt. This is an ongoing process.

Future research should examine other design variables of the online learning process to determine what in the course design influences interactions. It would also be productive to analyze other interaction instruments that students use to communicate. Other useful research might involve assessing the content of the interactions. Overall SNA can be used to examine and influence course design decisions.

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[1] One of the authors of the Ucinet software.

[2] The centralization Index measures the special condition of network in which an actor plays a central role by being highly connected to the network.