Emergence of the Most Knowledgeable Other (MKO): Social Network Analysis of Chat and Bulletin Board Conversations in a CSCL System

Binod Sundararajan
Dalhousie University, Halifax, Canada
binod@dal.ca

Abstract: By conducting a social network analysis of chat and bulletin board conversations in a CSCL (Computer-Supported Collaborative Learning) system and identifying some underlying factors that impact learning and collaboration at the individual level and group level, we detect the emergence of the Most Knowledgeable Other (MKO, Vygotsky 1930/78) among the CSCL classroom participants. The study spanned three semesters and eight different courses, all of which used both in-class and CSCL teaching, and data was collected using a combination of methodologies with questionnaires and archived chat and bulletin board conversations. To map emergent student communication patterns, social network analysis tools were used to analyze relational data, calculate centrality scores and identify the formation of cliques (maximal subgroups in a network). Structural equation modeling was then performed on the hypothesized model to determine the impact of these centrality measures and the social factors on students' perceptions of respect and influence in group decisions, knowledge gained and their satisfaction with their performance in the course (Sundararajan 2009). While the formation of social network structures due to student chat and bulletin board conversations did have some significant impact on how the students perceived whether they gained respect among their classmates and whether they had influence on work related matters in online discussions, the most interesting finding was the emergence of peer MKOs within these class networks. This in turn did appear to have some significant impact on the students' perception of conceptual and new knowledge gained during the course and this is explained with relevance to group effects like cohesion and clique formation. Following the works of Johnson, Johnson & Holubec (1986) on cooperative learning and referring to the mapping of Vygotskian ideas and instructional design considerations for online teaching and learning from Hung and Chen's (2001) work, adapted by Taylor (2002), a model is proposed to take advantage of such findings of MKO emergence in CSCL environments and incorporate them into teaching and learning situations in CSCL environments or otherwise. The proposed model is called the PI-Matrix (Participation-Interaction Matrix) and can be used to help lurkers and shirkers, become workers and take an active role in their learning.

Keywords: CSCL, Most Knowledgeable Other (MKO), Zone of Proximal Distance (ZPD), social network analysis, instant messenger, bulletin board, synchronous and asynchronous communication, participation, interaction

1. Introduction

For many educators and researchers, CSCL appears to be one of the most promising ways, not only to promote, but also to achieve changes in teaching and learning practices (Lipponen, Hakkarainen & Paavola in Strijbos, Kirschner, & Maartens eds 2004:31). The evolution of these computer-mediated systems (CMC) over the last few years has seen the use of these systems from mere one-way transmission vehicles (to replace face-to-face class lectures) for online distance education to more interactive and inclusive environments allowing for a more rewarding learning experience. For example, many university classes use WebCT® or Blackboard® (a class management system) to post topics on the discussion boards, post grades and manage student projects, while others use Wimba® or Elluminate® environments. The use of these discussion boards allows students to discuss topics related to the material they are learning in class, allows them to interact with one another and the instructor synchronously and asynchronously and also post, view and if required rate group projects. Students' participation in discussion board threads allows for greater interaction in their instant messenger and email interactions, as they have had a chance to read and assess their classmates' contributions as they progress through the course (Sundararajan 2009). Raising questions regarding the nature and extent of the interaction and its effects on student performance, Picciano (2002) examines performance in an online course in relationship to student interaction and sense of presence in the course and found that though there was support for a strong relationship between students' perceptions and perceived learning, the relationship of actual measures of interaction and performance is mixed and inconsistent depending upon the measures and requires further study. Reffay & Chanier (2002), describe a situation of distance learning based on collaborative production occurring within groups over a significant time span. They found that social network analysis was a good candidate for application to their experiment in order to compute communication graphs.

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2. Review of relevant literature

Designers of online environments and CSCL systems have striven to make online learning more interactive through the use of tools for instructor-student and student-student interaction using both synchronous (instant messenger) and asynchronous (electronic discussion boards) communication (Sundararajan 2009). Some researchers report that university students in online courses or in traditional face-to-face courses that include an online component appear to have found the online environment valuable for their learning (Ciba & Rakestraw, 1998; Morss & Fleming, 1998). Other researchers report that interactive online courses allow for democratic participation (Schallert et al., 1999), and also that all class members have equal access to the floor (Bump, 1990; Hiltz, 1986). However, Hübscher-Younger & Narayanan (2003) have argued that power and authority have to be granted, and in the classroom the students hold the ability to grant authority. While the institutional status of an instructor gives some initial authority, students must consent and comply with the teacher's plans to have authority. The reason for this, Hübscher-Younger & Narayanan (2003) note, is that despite the progressive teaching methodologies and CMC tools, the students still place authority with the teacher through valuing the teacher's opinions and approval. These student perceptions play a part in how the students view themselves and other members of their work groups for class projects, as well as how these groups perform and learn. So democratization in the classroom and the shared power relationship need not always result in all participants getting equal access to the floor. Also, asynchronous discussions are not limited by "real time," and allow each participant to contribute as much as she/he wishes to the group discussions. Hung & Chen (in Taylor 2002) lay down the instructional design considerations for online learning and teaching based on the principles of situated cognition and Vygotskian thought as illustrated in Table 1.

Table 1: Instructional design considerations for online teaching and learning - Source: Adapted from Hung and Chen, 2001 in Taylor (2002)

Principles of situated cognition and Vygotskian thought	Instructional design considerations for online teaching and learning
Commonality*: Learning is a social act leading to identity formation and associated membership of a community of practice*	*E-Learning environments should capitalize on social and collaborative communication with others who have shared interests*
Situatedness*: Learning is reflective, metacognitive and embedded in rich socio-cultural contexts*	*E-Learning environments should enable students to work on activities and projects that demand reflection on authentic practice*
Interdependency: *Learning is socially mediated and facilitated through engagement in practice with others*	*E-Learning environments should generate interdependencies that benefit from the diverse expertise in the learning community*
Infrastructure*: Learning is facilitated by activity, accountability and associated support mechanisms*	*E-Learning environments should incorporate facilitating structures, accountability mechanisms, and associated rules of engagement*

We thus see that a CSCL environment would have to take into account interactions among many people, mediated by various artifacts, and cater to the learning objectives of individuals and groups that will interact in this environment. The design of CSCL environments has involved the use of several learning styles like project based learning, scaffolding and communication, situated learning in communities of practice and educational theories like the theories of constructivism, collaborative interaction and activity theory. And it was recognized early on that a CSCL environment must contain all the aspects of computer-mediated communication like electronic mail, instant messenger, teleconferencing, videoconferencing (to provide for face-to-face interactions), presentation media (electronic whiteboards), and electronic discussion boards to name a few, in order to promote easier communication and foster social interaction among the students and thereby facilitate better learning outcomes as a result of these interactions (Sundararajan 2009). Of the many modes of CSCL, the threaded electronic discussion boards provide for a sustained and archived (at least for the duration of the course) asynchronous platform for students in class groups to exchange views, ideas and learning concepts in a democratic manner. Students can choose whether to post detailed messages or short responses as they engage in the learning and peer assessment process. The posting of messages on a discussion board is one way to enable asynchronous dialogue among students as they progress through the course. The asynchronous nature of these postings, though slower than instant messenger interactions (where small doubts can be easily answered by any of the students in

the conversation), allows them to think about the questions asked and construct detailed and possibly meaningful responses to the queries of their classmates (Sundararajan 2009). Chat (instant messenger) conversations on the other hand allow for a quick turnaround for responses and convey the feeling of being immediately heard and acknowledged.

As Taylor (2002) notes "It is clear, however, that there are quite different patterns of student interaction, which seem to be related to performance. "Given that the academic performance of the lurkers was on average not much less than that of the workers, it seems reasonable to suggest that the notion of learning through legitimate peripheral participation is indeed efficacious." He continues by saying, "however, it is also clear that students who have a more parsimonious approach to engagement are at risk of failure, since eight of the shirkers did not achieve an acceptable level of academic performance during the semester. Clearly, there is a need to conduct further research to define the parameters associated with minimal and/or optimal levels of participation that will provide students with a reasonable chance of academic success. This work would necessarily entail a qualitative dimension not only to "unpack" the reasons for varying degrees of engagement, but also to analyze the perceived value of particular interactions from a student learning perspective."It is the purpose of this research to unravel not only the structures and environments that best facilitate teaching and learning, but also lay out a plan to allow those who could be left behind due to any number of reasons, including feelings of social or academic inadequacy, fear of ridicule and exclusion and hence non-acceptance among peers, general discomfort with technology to name a few, to be empowered and move from being lurkers and shirkers in a classroom environment and become active workers and learners.

3. The study: Sample and methodology

Initial analysis of survey questionnaires determined that respect (whether real or perceived and not very different from esteem) as a social factor is important to people in order to validate themselves and the skills they bring to the table in collaborative work situations. Influence in a group and among class members and motivation to actively collaborate and not be a free rider, follow from the respect that the individual gets from group/class members. Both respect and influence, together and separately, were found to be instrumental in students' efforts to collaborate, learn new and conceptual knowledge and be satisfied with their performances in the courses (Sundararajan 2009). The study spanned three semesters and involved eight different courses (HCI, Engineering, Management, Technical Communication and Business) all of which were delivered to in-class students and distance students using WebCT and the Elluminate® CSCL tool. Chat and bulletin-board conversations were archived and this phase of the study consisted of performing social network analysis of these student conversations. Social network analysis is widely used in the social and behavioural sciences and focuses on relationships among social entities, like communications among group members, transactions between corporations or organizations and this focus on relationships can help reveal social network properties like centrality, prestige, prominence, and affiliation networks. Network analysis not only examines node-level indicators such as centrality, but also the pattern of connections among nodes by examining their clustering into subgroups. These interactions can be mapped into sociograms to reveal the structure of the network, the centralities of influential actors and the impact (if any) that they may have on one another. Several researchers have done extensive work using social network analysis to study CSCL and face-to-face environments and validated the use of this approach to study patterns of students' interactions in classrooms.

Based on the roles and positions students in class groups assign themselves, network communication patterns in CSCL systems will reveal student self perceptions of their influence in their groups and the respect they feel they get from their group members and this in turn will help in their assessment and learning processes. The role of the instructor also becomes a point of interest, to see how the instructor is able to facilitate both the assessment and the learning processes (Sundararajan 2009). Of the many roles that actors (students, in this case) can take in social interactions, roles that make them central to the group or class are usually favoured by the actors. This is so that they can leverage their positions for both individual benefit and also the group's benefit, if they channel information and knowledge among the various group or class members. Central actors who are aware of their positions will pay heed to suggestions by the peripheral actors and include them in the group activities and the group decision-making processes. With the concept of betweenness centrality and degree closeness Roberts & O'Reilly (1979) showed that peripheral actors were less satisfied than those with two or more links. Kilduff and Krackhardt (1993) examined and showed that betweenness centrality in friendship network is negatively related to satisfaction. Betweenness centrality allows an actor to be

either a control or conduit for information flow, between two or more other equally or more important actors.

4. Sociograms of chat and bulletin board conversations

The classes used the Elluminate® CSCL Tool, which has a Whiteboard, IM, Application Sharing, Web Access, VoIP and integrated video streaming of lectures and WebCT's Bulletin Board. The students were a mixture of on-campus and distance students (full time students and working professionals) and there were 358 students in all the eight courses. These courses were GMPM – Global Marketing and Product Management, CDW – Communication Design for WWW, FHCI – Foundations of HCI Usability, PP –Proposing and Persuading, ETC – IT and Decision Systems Capstone, SD – Studio Design in HCI, IB – International Business and TCTR – Theory and Research in Technical Communication. Of the various network measures that can be used to understand how information flows between nodes in a network, the most common measures are centrality measures which measure the importance of the node in the network and of these degree centrality, closeness centrality, and betweenness centrality measures are often cited in literature. Additional centrality measures are reach centrality, eigenvector, power, information and influence centralities. Other network measures such as cohesion (presence of subgroups/cliques), structural holes, network density, network transitivity etc. are used to understand individual and group behaviour in networks of different sizes. We will restrict our discussion to centrality measures as they are sufficient to illustrate the emergence of new actors in the network taking on leadership roles in directing class discussions and knowledge sharing.

As the name indicates, degree centrality indicates the number of lines coming in and out of a node (number of ties – in degree and out degree). When looking at friendship or knowledge sharing situations, we can look at in degree as an indication of popularity and out degree as an indication of extreme social behaviour willing to get in touch with many network alters (sending out friendship requests on Facebook®). Closeness centrality (based on the mean geodesic distance – shortest path between two nodes and can propagate via other network nodes), is useful to measure nearness of two nodes in the topological space where distance measurement is rather difficult. This shortest path is relative to other short paths in the network between these nodes in question. Betweenness Centrality, while also based on the shortest paths between nodes in a network identifies network nodes (actors) that occur on many shortest paths between other nodes. The interpretation is that network nodes (actors) with high betweenness centrality scores can act as 'controls' or 'conduits' for information flow between nodes in the network. For this reason I have chosen to focus on the betweenness centrality scores to indentify actors that as acting as 'conduits' for information flow in the network and hence facilitate knowledge sharing. Since Eigenvector centrality scores also appear in the tables below, it is important to know that eigenvector centralities indicate the importance of the node in the network, for example consider the PageRank® feature in Google searches.

The following figures and tables show the sociograms for some of the chat and bulletin board conversations and the centrality scores for the actors respectively (the betweenness centrality scores have been highlighted). UCINET software (Borgatti, Everett & Freeman 2002) was used calculate the centrality scores and map the network diagrams. While we look at individual actor centrality scores to get an indication of an actor's position in the network based on tie direction, nearness, betweenness etc., how these centralities are related provides more information about the whole network. For this we look at how centralized a network is (one that has one or a few actors very central to the network) or how decentralized a network is (many central actors). Because a highly central node can be a single point of failure in a network, fully centralized nodes with one or a few well connected hubs (those nodes with high betweenness and degree centrality scores) can fail suddenly. Networks that are more decentralized (sparse networks) have many central actors and do not have single points of failure. These networks provide multiple pathways via central actors for information flow, can withstand attacks to the network, and do not tend to fail suddenly. Chat and bulletin board networks can take on either property (highly centralized or highly decentralized), depending on the context. The general observed behaviour of people in chats and bulletin boards is that only a few participate regularly and with high frequency leading to fairly well centralized networks. However, since many of these networks are created ad hoc (for a project, a class etc.) they need not be sustained for long periods of time, so failure may not be an issue. However, if the prominent actors in a chat room stop writing or posting, then it is possible that the network may cease to exist after a while or newer actors will step up to take on the roles of those who have left the network. With this perspective, we can start looking at the chat and bulletin board networks for these classes/courses. While figure 1 indicates four

central actors (drgj-the instructor, ksks, calg and grj), the betweenness centrality scores suggest that apart from the instructor drgj, it is ksks who has a higher betweenness centrality score than his peers. However, the sociogram reflects only a small percentage of students enrolled in the class. Many did not participate actively in the chat discussions substantially, other than occasional queries.

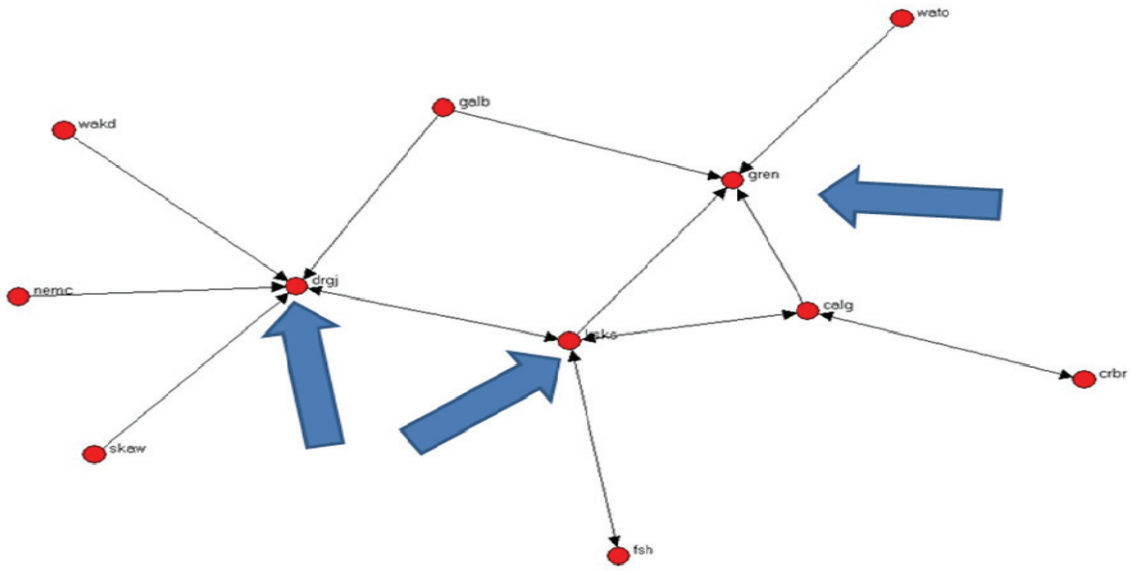

Figure 1: GMPM - Global Marketing and Product Management (chat sociogram)

It is interesting to note that the actor with the next highest Betweenness Centrality score, grj (26.667), while central, was more central in the bulletin board post network. She was the most prolific poster with over 52 of the 115 or so posts during the term. This actor was ready to help others in the network by providing answers to questions posed. However when asked who in the network she learned from and found knowledgeable, she mentioned that she did not learn from anyone else in the class. So it is interesting to see her centrality scores in the chat sociograms shown in figure 2, Degree Cent (40), Closeness Cent (52.632) and Betweenness Cent (26.667) and Eigenvector Centrality (64.683). Compare that with the scores of actor Ksk (Deg – 40, Closeness – 62.5, Betweenness – 46.667 & Eigenvector – 69.545). Viewing the bulletin board post sociogram will put this in perspective and this can be seen in figure 2. Here actor grj (denoted as gren) is most definitely the central actor, with actor ksk appearing outside the network in conversation with actor calg (denoted in Table 2 and Fig 1 as clg).

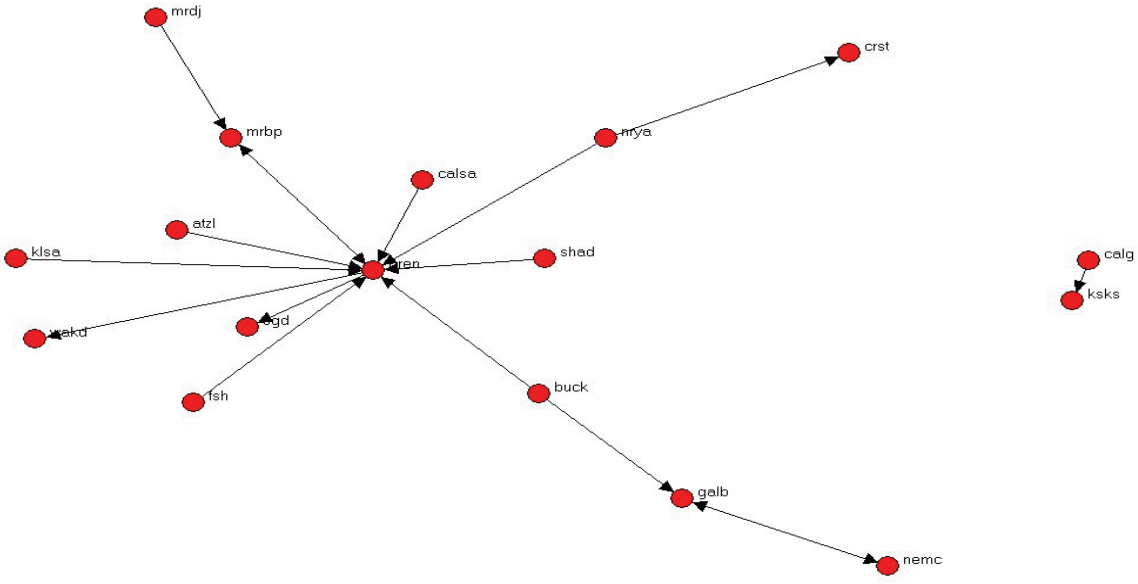

Figure 2: GMPM - Global Marketing and Product Management (bulletin board sociogram)

Table 2: GMPM - Global Marketing and Product Management (centrality scores)

Normalized Centrality Measures

		1 Degree	2 Closeness	3 Betweenness	4 Eigenvector
1	kashks	40.000	62.500	46.667	69.545
2	durgej	50.000	58.824	55.556	60.433
3	calleg	30.000	50.000	20.000	52.544
4	greenj9	40.000	52.632	26.667	64.683
5	fishr	10.000	40.000	0.000	23.985
6	corber	10.000	34.483	0.000	18.122
7	gallab	20.000	50.000	8.889	43.151
8	newmac	10.000	38.462	0.000	20.843
9	sukawn	10.000	38.462	0.000	20.843
10	walked3	10.000	38.462	0.000	20.843
11	waltot	10.000	35.714	0.000	22.309

The reading here can be that each actor might prefer one medium over the other. The bulletin board medium is asynchronous, giving actors time to compose their replies, while chat conversations are synchronous requiring actors to be able to respond to queries quicker. While some may prefer one medium (depending on the cue richness of the medium), over another, both of these allow participants to express their ideas and viewpoints and get them engaged and involved with the material or the topic of the discussion.

Turning our attention to the other classes (courses) we see a variety of centralized and decentralized networks. The PP class (a smaller class) on the other hand, shows a fully connected network and there was no clear central actor.

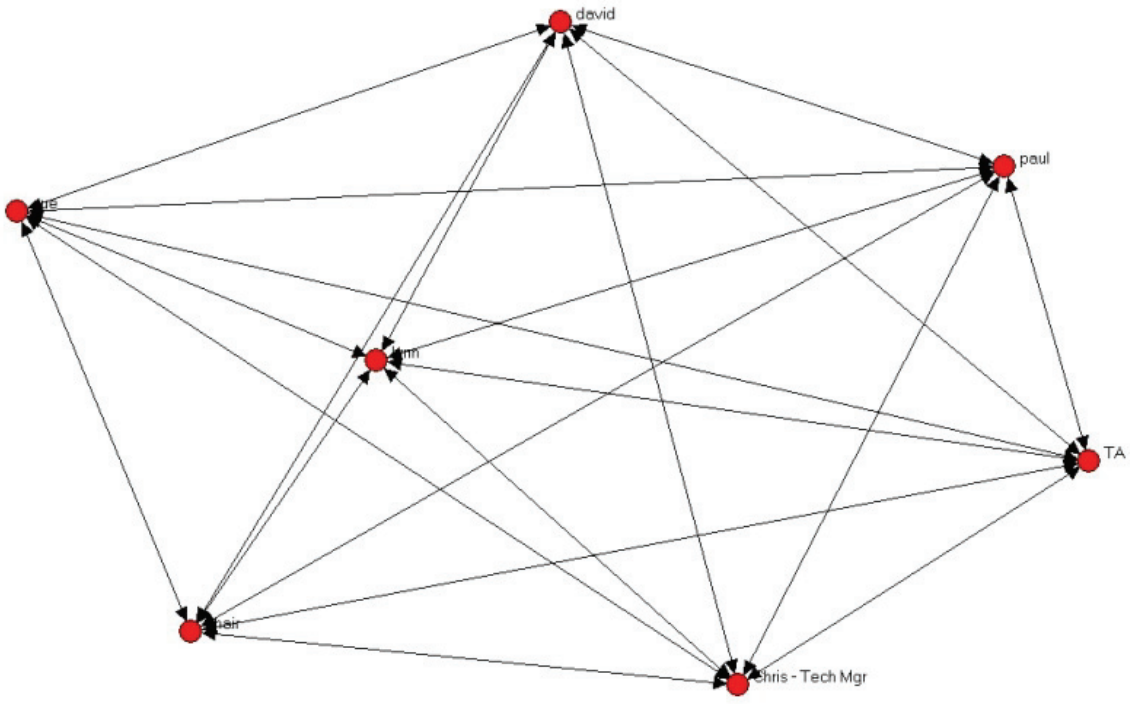

Figure 3: PP – Proposing and Persuading chat sociogram class 1

The fully connected network has the property of almost all the actors knowing exactly what the rest of the actors in the network know. It is said that no new information is created or propagated in such networks, while sparse networks are considered best for information propagation (friend of a friend of a friend – FOAF). Examples are trust and family networks vs. FOAF networks (LinkedIn® is one such example). This can be seen in the centrality scores shown in table 3.

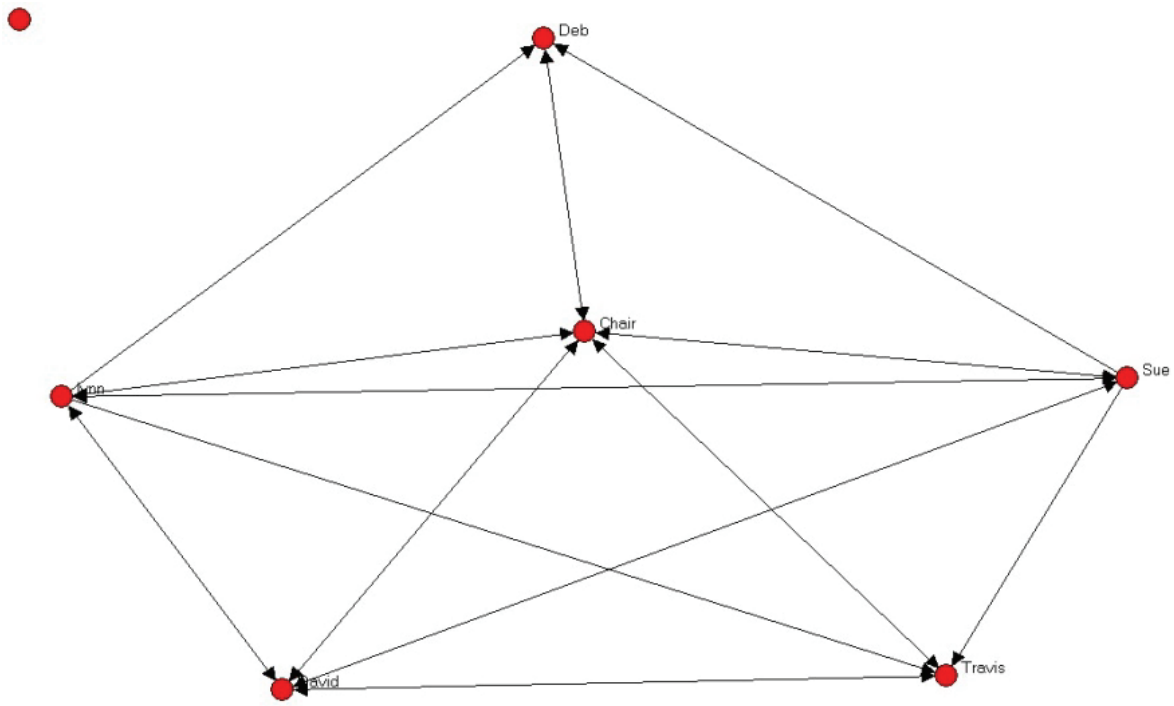

Figure 4: PP – Proposing and Persuading chat Sociogram class 9

Table 3: PP – Proposing and Persuading – centrality scores

Normalized Centrality Measures

		1 Degree	2 Closeness	3 Betweenness	4 Eigenvector
1	Sue	83.333	50.000	4.444	63.303
2	Chair	83.333	50.000	4.444	63.303
3	Deb	50.000	42.857	0.000	42.889
4	Travis	66.667	46.154	0.000	55.401
5	David	66.667	46.154	0.000	55.401
6	lynn	83.333	50.000	4.444	63.303
7		0.000	14.286	0.000	-0.000

As can be seen from the centrality scores in Table 3, and the fully connected network sociograms in figures 3 and 4, there are more than a few central actors. This being a small network (class size was around 12-15, with the remaining actors not participating in any discussions), the few actors that are central (anybody who posts anything can become central) share ties, closeness and importance. However, we do note that there are a few who occupy 'conduit' positions indicating information exchange through these highly between nodes in the network.

Figures 5, 6 and 7 depict the chat sociograms for the CDW course for classes 1, 3 and the last class respectively. In addition to the "chair" (the TA or the instructor), actors Chris, Will and Teresa occupy central roles in the class chat discussions. This can be seen by their high betweenness centrality scores in tables 4, 5 and 6. What is interesting, however, is as the semester progressed, while actors Chris, Will and Teresa continue to hold fairly central positions in the chat discussion networks, other actors emerged throughout the semester to occupy fairly equal roles.

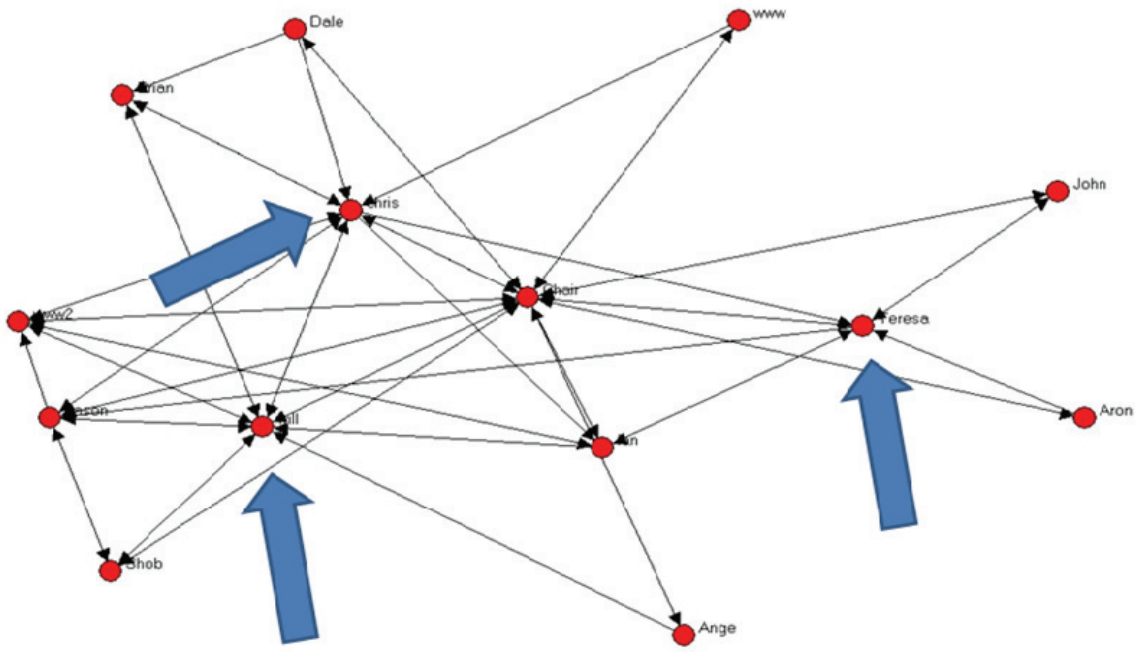

Figure 5: CDW – Communication Design for WWW – chat sociogram class 1

This can be seen by the emergence of actors Brian, Jason and Ian (Figure 5 and Table 5) and actor Dale (Figure 6, Table 6). Consequently the betweenness centrality scores of actors Chris, Will and Teresa appear to decrease as the semester progressed indicating that other actors were allowed to not only voice opinions but also take up central roles in the discussions.

Table 4: CDW – Communication Design for WWW – centrality scores class 1

Normalized Centrality Measures

		1 Degree	2 Closeness	3 Betweenness	4 Eigenvector
1	www	15.385	54.167	0.000	19.261
2	chris	69.231	76.471	10.299	45.708
3	will	61.538	72.222	7.521	50.629
4	Ange	15.385	54.167	0.000	18.458
5	John	15.385	54.167	0.000	16.397
6	Chair	100.000	100.000	45.769	66.162
7	Dale	23.077	56.522	0.000	24.173
8	Brian	30.769	59.091	0.427	31.082
9	Jason	46.154	65.000	2.137	43.595
10	Aron	15.385	54.167	0.000	16.397
11	Teresa	46.154	65.000	4.744	37.590
12	Ian	38.462	61.905	0.641	39.589
13	Shob	23.077	56.522	0.000	25.348
14	www2	38.462	61.905	0.256	40.409

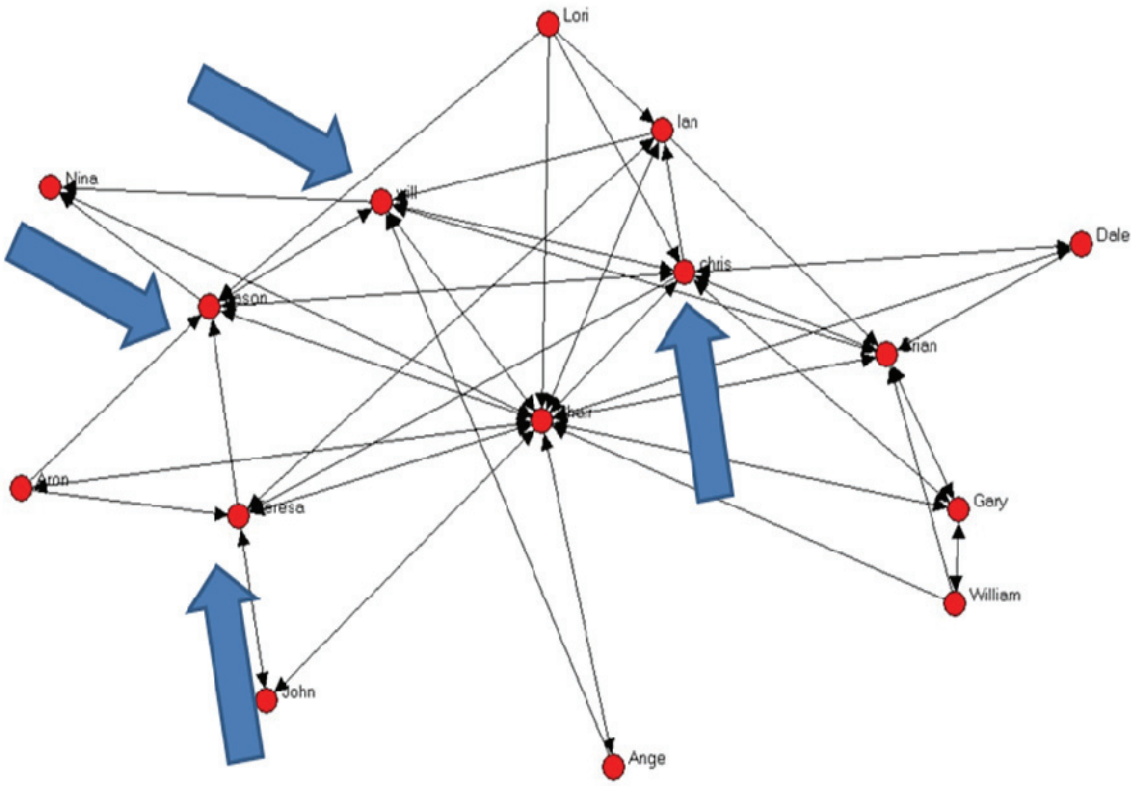

Figure 6: CDW – Communication Design for WWW – chat sociogram class 3

The "chair" actor (instructor or TA) did lead several discussions and answer queries, content analysis of the conversations indicate that student actors did have a considerable say in how the discussions continued. This was evident in conversations in almost all the courses, not just the CDW course.

Table 5: CDW – Communication Design for WWW – centrality scores class 3

Normalized Centrality Measures

		1 Degree	2 Closeness	3 Betweenness	4 Eigenvector
1	Gary	28.571	58.333	0.366	27.716
2	chris	64.286	73.684	7.271	53.690
3	will	50.000	66.667	4.799	43.163
4	Ange	14.286	53.846	0.000	16.620
5	John	14.286	53.846	0.000	15.608
6	Chair	100.000	100.000	45.733	66.551
7	Dale	21.429	56.000	0.000	24.587
8	Brian	50.000	66.667	3.846	42.064
9	Jason	50.000	66.667	4.304	41.744
10	Aron	21.429	56.000	0.000	21.932
11	Teresa	42.857	63.636	3.333	36.485
12	Ian	42.857	63.636	1.557	41.318
13	Nina	21.429	56.000	0.000	22.944
14	Lori	28.571	58.333	0.220	30.798
15	William	21.429	56.000	0.000	20.652

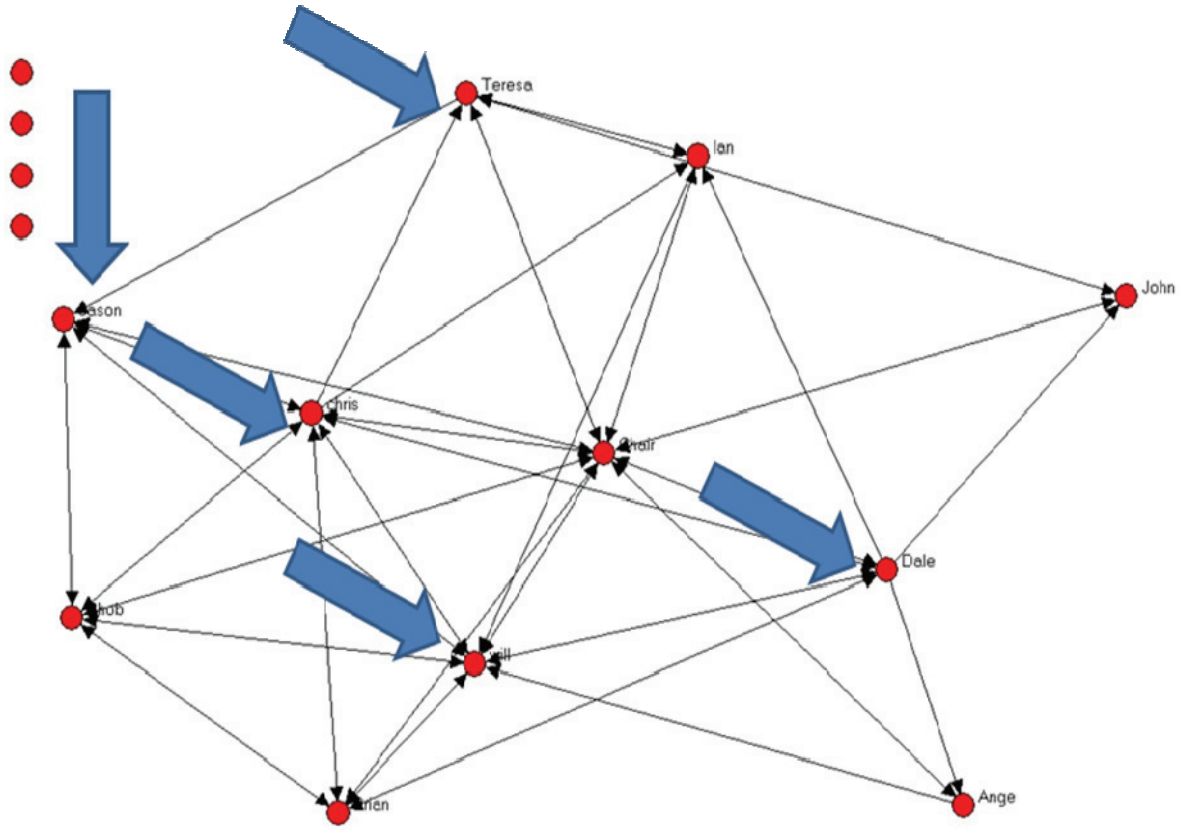

Figure 7: CDW – Communication Design for WWW – chat sociogram last class

Continuing to look at other classes, we note the same phenomenon repeating itself as during the course of the semester new actors emerged to take on central roles in class discussions.

Table 6: CDW – Communication Design for WWW – centrality scores last class

Normalized Centrality Measures

		1 Degree	2 Closeness	3 Betweenness	4 Eigenvector
1	chris	57.143	19.444	3.297	54.706
2	will	57.143	19.444	4.029	53.568
3	Ange	21.429	18.182	0.000	25.170
4	John	21.429	18.182	0.275	22.043
5	Chair	71.429	20.000	10.623	31.093
6	Dale	50.000	19.178	3.755	46.209
7	Brian	35.714	18.667	0.275	39.774
8	Jason	35.714	18.667	0.641	37.798
9	Teresa	35.714	18.667	1.557	33.580
10	Ian	35.714	18.667	0.549	38.983
11	Shob	35.714	18.667	0.275	38.636
12		0.000	6.667	0.000	0.000
13		0.000	6.667	0.000	0.000
14		0.000	6.667	0.000	0.000
15		0.000	6.667	0.000	0.000

Interestingly, the bulletin board discussions for the CDW course were almost non-existent, indicating that possibly this set of students preferred instant messenger interactions to the asynchronous bulletin

board discussions or maybe the course material may not have warranted much asynchronous discussions.

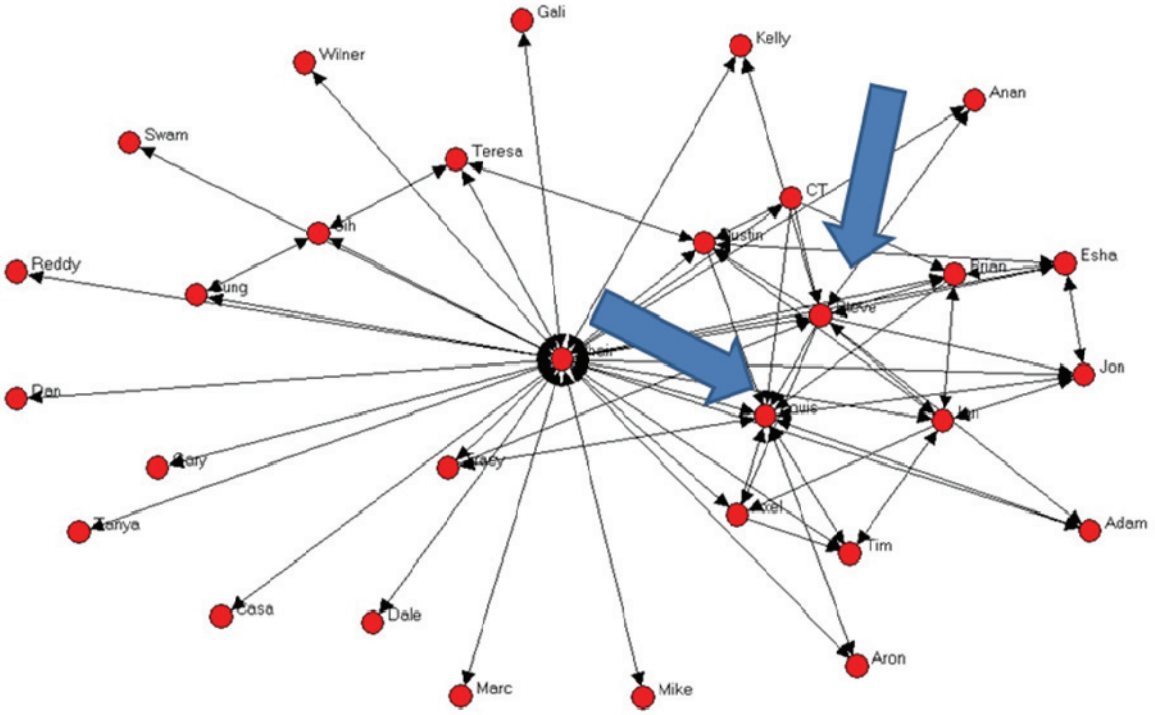

Figure 8: FHCI – Foundations of HCI – chat sociogram

Figure 9 depicts the rather sparse sociogram of the FHCI course bulletin board discussions, indicative of the general trend of bulletin board discussions. For the sake of space, only some of the sociograms of the various courses are presented. This is contrary to the behaviour seen in the chat sociogram for the same class (figure 8). There is a lot more activity in the chat conversation. This is to be expected as students are sitting in for class – co-located or from a distance and would like many doubts clarified as they keep pace with the lecture.

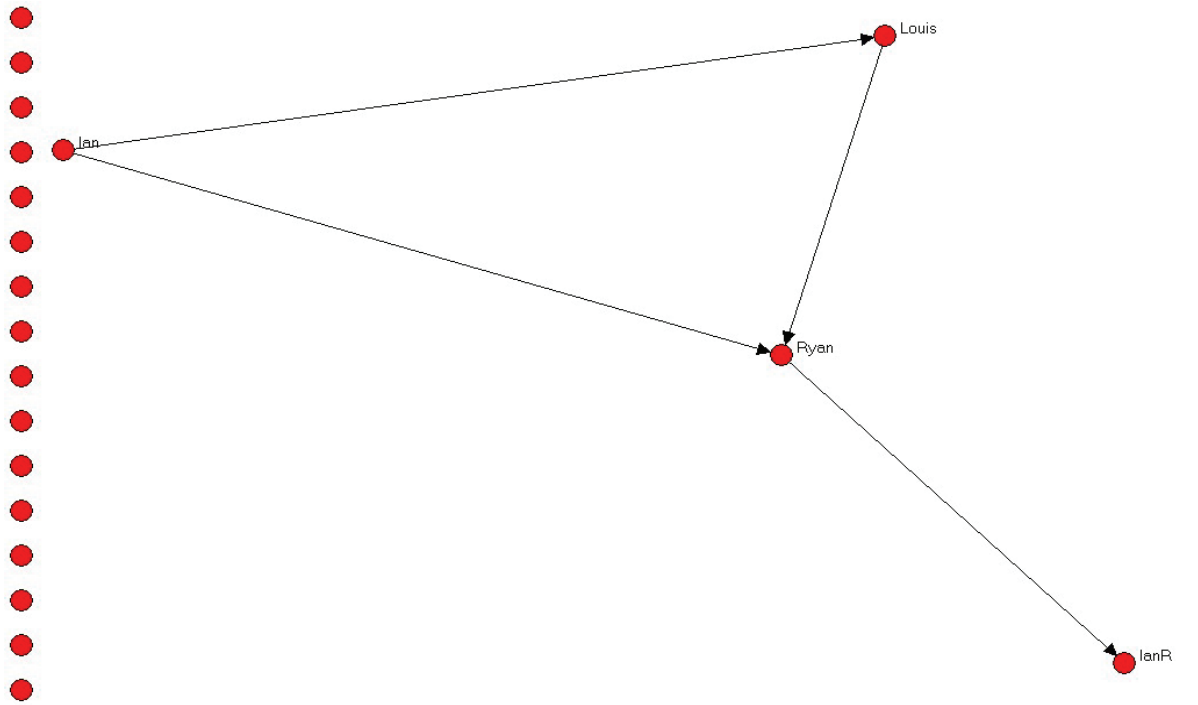

Figure 9: FHCI – Foundations of HCI – bulletin board sociogram

Table 7: FHCI – Foundations of HCI – centrality scores

Normalized Centrality Measures

		1 Degree	2 Closeness	3 Betweenness	4 Eigenvector
1	Lou s	37 931	61 7 2	3 177	45.23 4
2	Sih	10.345	52 72	0.123	12.21
3	Chair	100.000	100.000	80.897	71. 37
4	Dustin	24.138	56.8 3	0.873	34.7 7
5	Steve	44.328	84.4 4	4.850	51.4 4
6	Tim	13 793	53 7 1	0.035	22.86
7	Adam	10.345	52.727	-0 000	21.238
8	Aron	6.897	51.786	0.000	14.720
9	Brian	20.690	55 768	0.257	32.85
10	Dan	3.448	50 87	0 000	8.993
11	Jon	17 241	54.71	0 134	29.084
12	Esha	17.241	54.71 7	0.140	27.75 2
13	Dale	3.448	50 87	0.000	8.993
14	CT	17.241	54.71	0.041	29.78
15	Sung	6 897	51.78	0.000	10 54
16	Mike	3 448	50 87	0 000	8.993
17	Teresa	10.345	52.7 7	0.123	14.9 9
18	Ian	24.138	56.863	0.632	34.220
19	Aran	6.897	51.78	0.000	15.51
20	Kelly	6 897	51 786	0 000	15 51
21	Marc	3.448	50.877	0.000	8.993
22	Tanya	3 448	50.877	0.000	8.993
23	Gary	3.448	50.877	0.000	8.993
24	Gali	3.448	50.877	0.000	8 993
25	Reddy	3 448	50 877	0 000	8 993
26	Axel	17.241	54.717	0.097	28.438
27	Casa	3.448	50.877	0.000	8.993
28	Swam	3.448	50.877	0.000	8.993
29	Wilner	3.448	50 877	0.000	8.993
30	Tracy	10 345	52 727	-0.000	21 238

Of all the bulletin board discussion sociograms in the eight courses, ETC was the only course that had a significant number of discussion posts and figure 10 depicts the most active of the discussion threads. We note that chat conversations during the lecture are not only productive, but preferred. Discussion board or bulletin board conversations are generally sparse and unless specifically driven (as in the case of the ETC course), tend to have at the most 1-3 posts on average and very little by way of sustained discussion. Network position (betweenness centrality) has a significant relationship with influence obtained among peers.

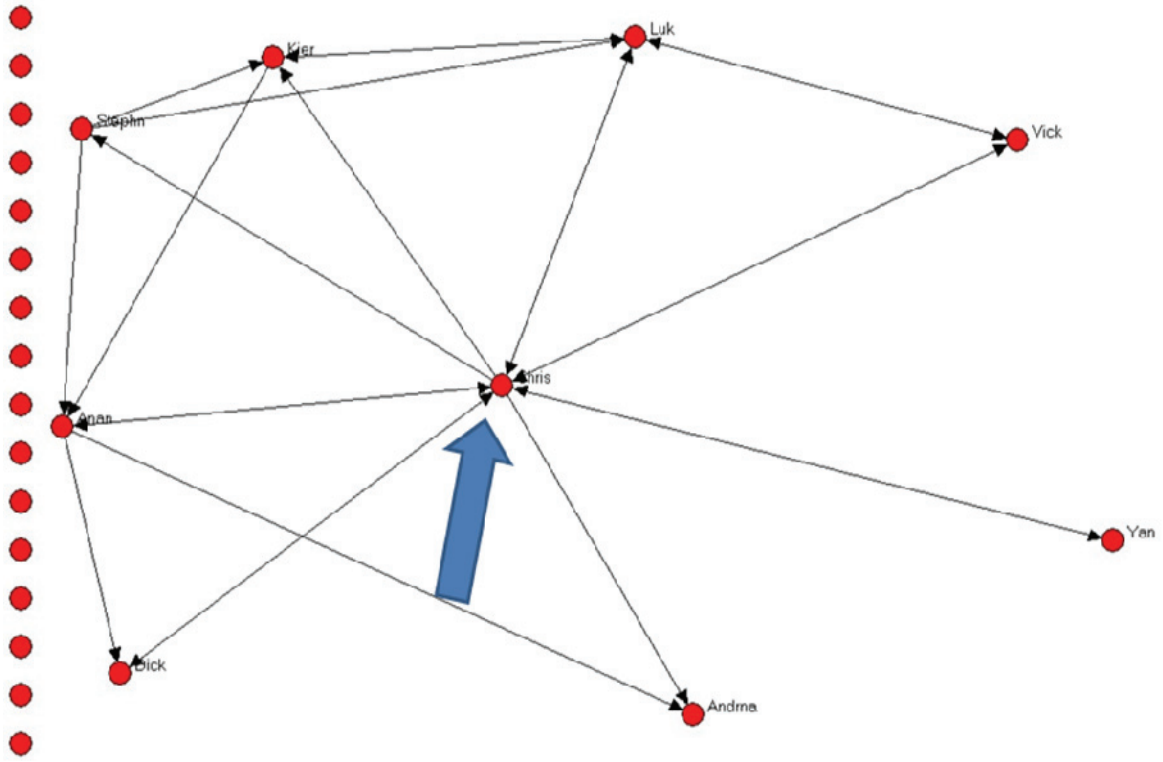

Figure 10: ETC – IT and decision systems capstone – chat sociogram

Table 8: ETC – IT and decision systems capstone – centrality scores

Normalized Centrality Measures

		1 Degree	2 Closeness	3 Betweenness	4 Eigenvector
1	Yan	3.448	4.496	0.000	17.248
2	Luk	13.793	4.517	0.246	49.080
3	Chris	27.586	4.545	3.900	74.390
4	Dick	6.897	4.503	0.000	30.353
5	Anan	17.241	4.524	0.616	56.518
6	Andrna	6.897	4.503	0.000	30.353
7	Vick	6.897	4.503	0.000	28.628
8	Kier	13.793	4.517	0.082	54.329
9	Stephn	13.793	4.517	0.082	54.329
10		0.000	3.333	0.000	-0.000
11		0.000	3.333	0.000	-0.000
12		0.000	3.333	0.000	-0.000
13		0.000	3.333	0.000	-0.000
14		0.000	3.333	0.000	-0.000

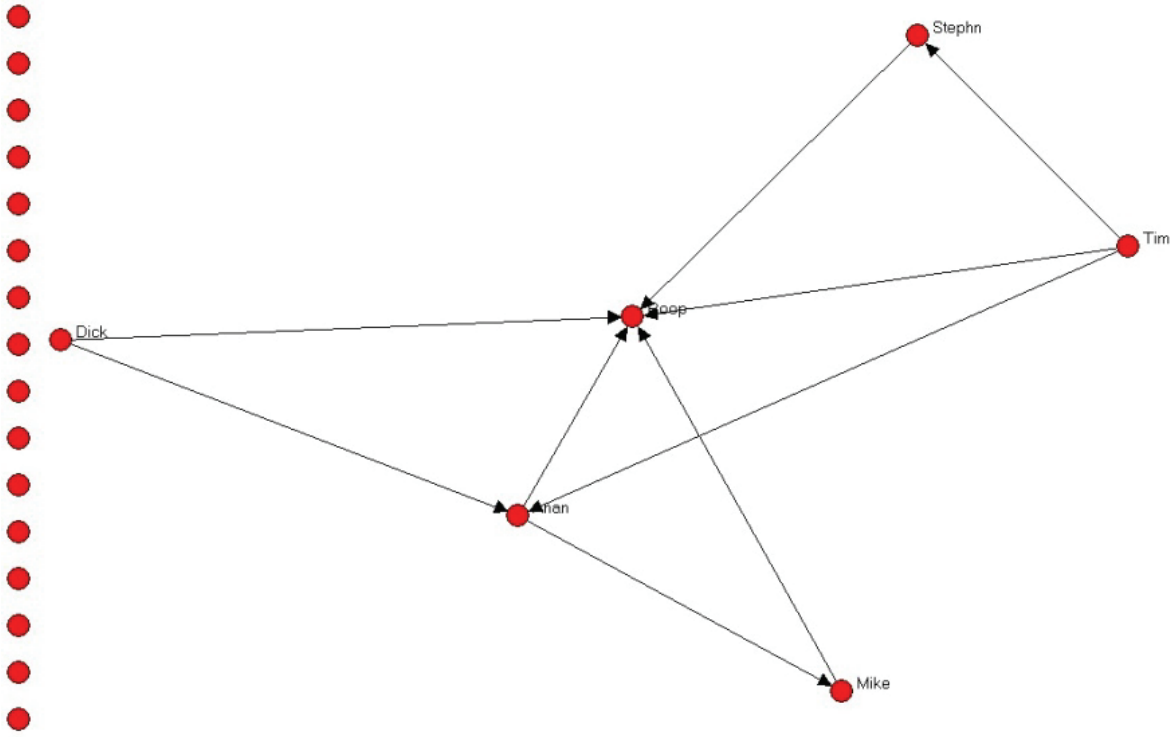

Figure 11: ETC – IT and decision systems capstone – bulletin board sociogram

5. Discussion and proposed student engagement model – PI matrix

As discussed earlier, betweenness centrality was chosen as it can indicate whether an actor uses their central position to be either a conduit or a control for information. In the above sociograms it appears that the actors with higher betweenness centrality scores did indeed act as conduits for information and knowledge and throughout the semester as the course progressed and students learned more, became more confident of their knowledge gained, and respect and influenced motivated students to participate in IM, Email and bulletin board conversations. The results of the

email networks were reported elsewhere (Sundararajan 2009). This appears to have had an impact of allowing more students to take up central positions and facilitate peer interaction, knowledge sharing and learning. Bulletin board conversations, however, were sparse across most of the courses and this is an indication of the students' preferred mode of interaction and at times how the courses themselves were structured.

Recalling the instructional design considerations for online learning and teaching from Table 1, where learning is a social act leading to identity formation, we understand the need to create e-learning environments that capitalize on the social and collaborative communication among those with shared interests. Where learning is reflective, metacognitive and embedded in rich socio-cultural contexts, the e-learning environments should facilitate activities that demand reflection on authentic practice. Where learning is socially mediated and rises from engagement in practice with others, e-learning environments should generate interdependencies rising from the diverse expertise in the learning community. And, where learning is facilitated by activity, accountability and other support mechanisms, e-learning environments should incorporate facilitating structures (network structures and others), peer review mechanisms and formalized rules of engagements.

In this study I only looked at the relationship networks formed by students taking courses in a CSCL environment. However, there could be other networks that these students belong to, such as other class friendship networks, residence hall networks, family networks, which may as well have an impact on their motivation to participate, but were not investigated here and a more complete one will include those as well. Also, individual differences like self-regulatory habits of highly motivated actors could be another factor that could impact the optimum use of the environment and the resources.

What became evident was that as the students' knowledge levels increased, they appeared more prominent in the class networks and more willing to share their knowledge with their peers. The instructor starts out as the most knowledgeable other - MKO (Vygotsky 1930/1978) in the class and is entrusted with the charge of helping the student(s) cover the Zone of Proximal Distance (ZPD) for a particular subject area. If it is indeed true, as seen from the above network sociograms, these instant messenger mechanisms (and occasionally the bulletin board discussions) facilitate the emergence of peer MKO's in a classroom, then this not only increases the level of effectiveness of the instructor and the CSCL environment, but also gives teachers and learners a clue as how best to engage students in a learning environment and hopefully help lurkers and shirkers (Taylor 2002) overcome any inhibitions or issues they may have and enjoy a more rewarding learning experience.

As Taylor (2002) notes, "we need to define and provide minimal or optimal levels of participation that will provide students with a reasonable chance of academic success and that this work would necessarily entail a qualitative dimension not only to "unpack" the reasons for varying degrees of engagement, but also to analyze the perceived value of particular interactions from a student learning perspective". What then entails active interaction or participation and are there indeed differences in these seemingly similar meaning terms? Does participation alone indicate involvement or do frequent interactions indicate interest and do either or both indicate if any learning occurred? While I have advocated the incorporation of peer assessment tools to support reputation building, rating systems to motivate students to participate and even have anonymous voting mechanisms for decision-making to avoid Groupthink (Sundararajan, 2009), I feel that results from this phase of the study indicate that much more needs to be done to actively engage the students in classes, be they face-to-face or CSCL environments.

In this attempt, I propose a model called the PI matrix or the Participation-Interaction Matrix (figure 12) to use as a possible guide in our attempt to engage the lurkers and shirkers and also give the workers a platform to showcase their knowledge. This model is a first-step in this approach and further research will determine the efficacy (or not) of this approach. The underlying assumption here is that workers are those students who interact and participate in class and group discussions, take the lead in decision making, generally do well in the course, are motivated to learn and are also willing to share any knowledge gained with their peers. This however does not mean that lurkers, who often perform just as well as the workers (Taylor 2002) but are less sure about vocalizing their opinions in social and group contexts, do not share their knowledge with their peers. They just seem uncomfortable doing so publicly and require as much attention and facilitation to bring them out of their comfort zones of non-interactive participation. We then come to the shirkers and the interactive shirkers. Interactive shirkers often make the appropriate noises to create a sense of participation, but

can tend to free-ride on the work of their more active peers. While this may work on occasion and help them get through a few courses, in the long run, they suffer and often have a poor performance to show for their efforts (or lack thereof). Finally the shirkers are thus for reasons best known to them, but with the right inputs from the instructor/facilitator and peer MKOs they too can be motivated to not just interact and participate but thrive and learn.

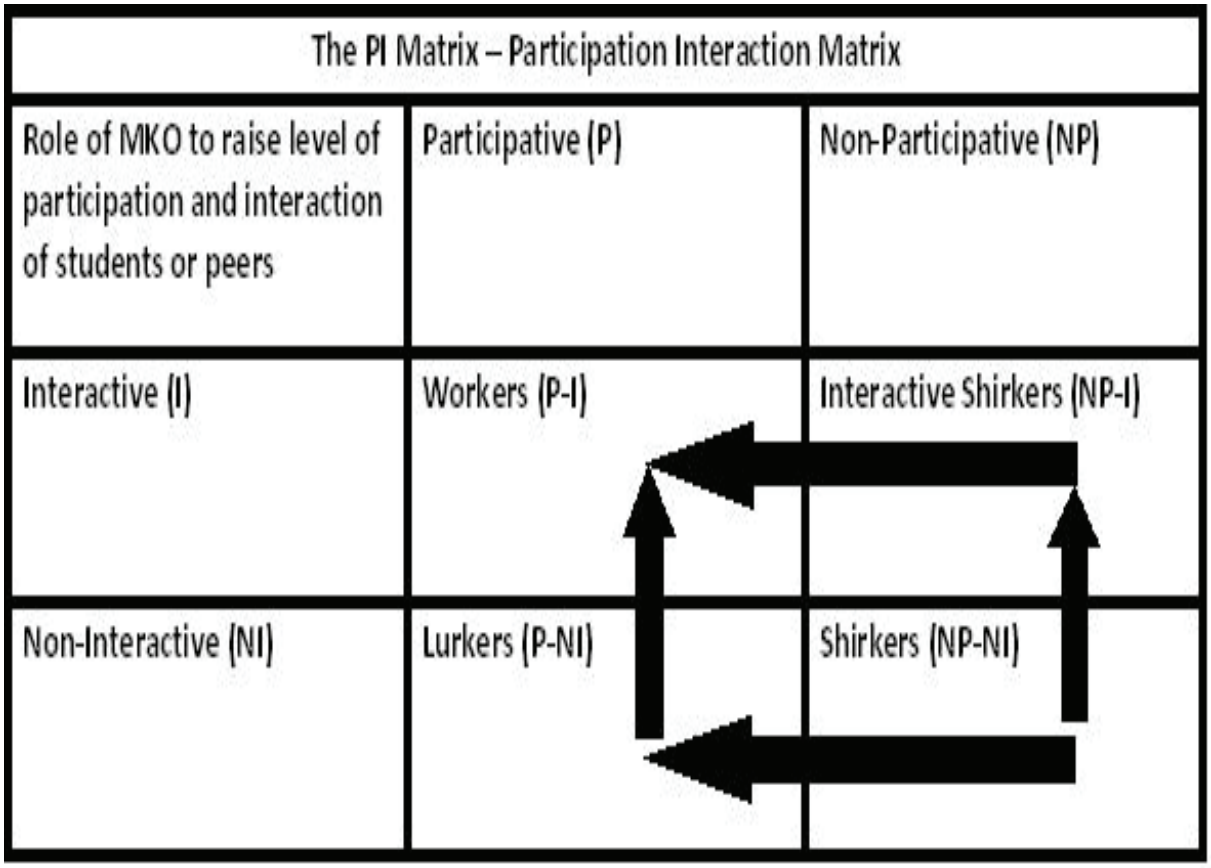

Figure 12: The participation-interaction matrix or the PI matrix

The role of the instructor now becomes even more significant as we can spot the MKOs in the classroom and empower them to bring their peers into the discussions. Considering the inherent authority status of the instructor, if the instructor were to relinquish some of this to these student MKOs, visibly encouraging MKO type behavior and nurturing the emergence of new MKOs, it would go a long way in creating the right environment for increased participation, interaction, engagement and hopefully learning. Respect plays a vital role in this effort. Treating all students with respect and dignity is the first step and most instructors do that already. However, the goal is to move beyond that and provide value to the students. When students recognize the intrinsic and extrinsic value of the subject matter to them, the ensuing peer and faculty driven discussions that require active interaction and participation that highlights this value and the resulting epiphany that often follows, then they will be more inclined to actively interact, participate and learn. Content analysis of the chat and discussion board conversations indicate the high levels of validation, agreement and rise in confidence levels as inputs are debated and accepted (sometimes refuted with valid arguments) reaffirm this approach. Case study approaches in non-management disciplines and role-playing (not MMORPGs, the efficacy of that approach is being studied by other researchers, but organizational roles-managers, scientists, engineers etc. in simulated problem-solving scenarios) is an effective tool and is the subject of one of the current works-in-progress of the author.

It is usually also easy for faculty members to identify the workers, lurkers and shirkers in the class and once this is done, the next step is to facilitate the emergence of MKOs by creating an environment that lurkers and shirkers feel safe to contribute in. The instructor can then encourage the self-motivated workers (often the earliest to emerge as MKOs) to lead discussions and share information and knowledge, all the while providing both summative and normative feedback and fair assessments. Again, most faculty members do this. The next step is the most crucial one, in which the instructor/faculty member relinquishes some authority (peer assessment, peer-to-peer feedback

and discussion leading) to not just the early MKOs, but also others who are on the fringe and with just the right amount of recognition and prestige effects can emerge as MKOs. With the shirkers, a combination of some authority and leadership role-playing opportunities can often result in dramatic turnaround, simply because of the expectations of leadership responsibilities and peer feedback. While I can attest to a fair amount of success using this approach in my own teaching, I have yet to conduct specific studies so as to officially report any results. These will usually be the lurkers.

What I can however mention are some student comments to this approach. In each of my classes, students are assigned to groups and these groups are designated as different departments in an organization (sales, manufacturing, accounts, executive etc.) and there are usually three organizations in the class – a primary vendor (for goods or services), a client and a third organization that is either a vendor partner or a client partner. The client issues an RFP (request for proposal) for some goods or services and the primary vendor responds to the RFP. In this simulated scenario, students learn the various aspects of business communication, problem solving, critical thinking, collaboration and writing and presentation skills. Each problem is considered as a case that the student groups have to actively discuss about and come up with a solution. Every other week at the end of my lectures, I ask the students to give in one sentence what they took away from that lecture, their participation during that lecture and their interactions with their class members and here are a few comments.

> *"Great class! The case-study style of teaching is a much better way to teach classes. Please continue to use this style."*
>
> *"I have learned about our project and different organizations and roles. Met new people and learned the importance of interactions between sections of a company and the people."*
>
> *"I learned how to analyze audiences to be able to communicate with people properly."*
>
> *"Communication is much more complex and important in business than I realized."*
>
> *"Today I learned that 45 seconds can be more stressful than you think." – with reference to an elevator pitch assignment.*
>
> *"It was incredible how different it feels to be on the spotlight."*
>
> *"Today I learned to be confident and clear and not to be nervous. Everyone was good."*
>
> *"I have a better understanding of roles in industry from the project we did in class. They're based on real events and are happening right now."*
>
> *"It was interesting to note the dynamics of the NHL and that played into our simulated project. I learnt a lot. I wish we had gotten that seventh team." – with reference to a NHL hockey franchise bidding battle.*

Lack of space prevents me from citing more student comments. However, my takeaway from these comments and the results of the study discussed above are that students feel more confident to vocalize their thoughts and opinions when they realize that they are 1] in a safe environment, 2] they and their opinions are respected, 3] their peers recognize their efforts and encourage them to do better, 4] they have influence in their group's decision making processes 5] the instructor and the other seemingly knowledgeable peers (MKOs) validate their participation and interaction efforts and 6] leadership and decision-making opportunities give them confidence and motivates them to participate, interact, learn and get value from their involvement in class activities.

This is definitely possible in e-learning environments, where structures and forms exist that can facilitate peer engagement (via seeded discussions in bulletin boards), peer assessment (normative and summative feedback mechanisms can be instituted) and generate enough interest for even the most laggard of shirkers to participate. Also, there are ways to facilitate both task related and social conversations that allow students to be involved, engaged, respected and motivated to participate. The choice of anonymity (not posting student profiles) allows for increased participation, but social censure and rebuke from peers is an equally powerful motivator. Often, associating these behaviors with marks for the course does generate a flurry of activity, but even if students are forced to participate the shirkers (despite themselves) can actually end up acquiring some semblance of knowledge.

The next step in this approach is to design studies to specifically measure interaction and participation (non-interaction and non-participation also) levels to test the efficacy of the model. The findings from this research will be useful in the design of courses for both face-to-face and CSCL environments take advantage of reputation and influence metrics to stimulate student participation, interaction and learning, and also help shirkers and lurkers become active learners.

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