EMERGENCE OF EPISTEMIC AGENCY IN COLLEGE LEVEL EDUCATIONAL TECHNOLOGY COURSE FOR PRE-SERVICE TEACHERS ENGAGED IN CSCL.*

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ABSTRACT
Written interaction between pre-service teachers engaged in progressive inquiry using Knowledge Forum in two intense summer courses were analyzed to detect and rank those students in terms knowledge sharing, pressing on for further inquiry and the number of partners they communicated with. Social network analysis techniques were employed to cluster students in terms of their network centrality using a Freeman's betweenness value, where higher values indicated more communication flow occurred through that person. An aggregate score is calculated for each student and they were ranked into four levels of epistemic agency ranging from exceptional to low. Nearly half of the students in both courses ranked in the lowest level of epistemic agency interpreted as following mostly their own epistemic goals with minimal knowledge sharing with few partners and mediating little of knowledge sharing and collective inquiry. There were two to three students in each course with outstanding score in all of the five criteria and the others dispersed evenly from moderate to high. Both courses gave a low network centrality value indicating that the communication was not concentrated over a few individual but evenly scattered among the members. Epistemic agency is defined, and the analysis and rankings are elaborated with tables and charts.

Keywords: Epistemic agency, Knowledge building, Social network analysis (SNA), Progressive inquiry, Cognitive authority and responsibility.

INTRODUCTION

This study analyses the patterns of interaction among college students collaborating in an educational technology course. Students participated in a progressive inquiry in order to advance their explanations of shared problems with verbal and written contributions. Students generated their own conjectures on shared problems within a course that is structured and supported an extended collaborative discussion of student ideas. The purpose of the present study is to identify a specific type of agency assumed by students in the collaborative process of inquiry that ranks them in terms of cognitive authority and responsibility in pursuing collective epistemic goals. Scardamalia (2002) defines this epistemic agency as what emerges when students set forth their own ideas, negotiate a fit between their personal ideas and that of others, and take charge of their own knowledge advancement. The inquiry is brought forth through the interactions of learners with a collective effort towards a shared understanding of their ideas regarding the problems inquired about. Technologies can be designed to structure and support inquiry (Edelson, Gordin & Pea, 1999). In this study, students' collective inquiry relied on socially distributed cognitive resources that were generated by their social interactions in class and online using Knowledge Forum which is a second generation CSCL technology. Students' written interaction was analyzed in order to detect and rank them in term of their epistemic agency ranging from low to exceptional. Social network analysis techniques were employed to interpret interpersonal contact among the student, and k-means statistical analysis was performed to cluster students into four distinct levels of epistemic agency.

Epistemic goals

All students pursue epistemic goals when their efforts are directed for understanding something in school as they may try to meet course requirements or turn their understanding into practice. Traditionally teachers assume and manage the cognitive aspects of thinking and problem solving in the classrooms. In their effort to lead students to mastering a body of preconceived knowledge and skills the teachers usually set the main learning goals, monitor how students fair in making progress, and evaluate the outcomes. A competent teacher may be able to skillful gauge the complexity of their subject matter and streamline their instruction in order not to overwhelm students in reaching the learning goals. Such knowledgeable teachers are not only hard to find but also a deeper understanding usually will take more than just direct instruction (Palincsar, 1998; Bereiter & Scardamalia, 2008). Students who desire to follow their epistemic goals and wish to inquire more for a deeper understanding are likely to be underserved in traditional task-completion oriented classrooms that can spare minimal time and support for uncertain personal outcomes. On the other hand, some pedagogical structures such as self-regulated and co-operative learning and guided discovery (Brown & Campione, 1994) are notable systematic attempts to have more student role in learning. Collaborative learning offer more chances for students to work for a shared understanding as in the cases of project-based learning (Lee & Butler, 2003) and problem-based learning (Evensen & Hmelo, 2000), but neither the projects nor the problems are about idea improvement or knowledge advancement per se, and despite the considerable liberties given to students, their understanding can still be

surpassed by a collective effort through a sustained inquiry towards a shared understanding with new insights that can only come out collectively (Bereiter & Scardamalia, 2008). Bereiter and Scardamalia (Bereiter, 2002; Scardamalia & Bereiter, 1994) have devised a knowledge building pedagogy based on production and continual improvement of ideas of value to a community. Student ideas are offered individually and then improved collectively, where all members share the cognitive responsibility and feel the epistemic agency at varying levels.

Epistemic agency

A number of studies incorporated epistemic agency as an indicator of knowledge creation in collective processes with shared knowledge objects (Muukkonen & Lakkala, 2009), construct for setting, monitoring and evaluating collective learning goals (van Aalst & Chan, 2007), as a heuristic framework for progressive inquiry and a worthy goal for college education (Muukkonen et al, 2005), as an aggregate factor collective cognitive responsibility (Zhang, Scardamalia, Reeve & Messina, 2009), as a capacity for deliberate collaborative work (Damşa, Kirschner, Andriessen, Erkens & Sins, 2010), and as a defining characteristic of groups that decide as a group (Tollefsen, 2004).

Epistemic agency is not merely concerned with epistemological elements, such as just knowledge in itself, but also with the complex combination of qualities that permit a student to deal with knowledge, with learning in collaboration, and to be efficient when learning (Hakkarainen, 2004; Hakkarainen, 2009). The knowledge building model is employed in many schools as well as businesses and organizations with a focus on knowledge work. Epistemic agency is regarded as assuming cognitive responsibility in knowledge building which is more about shared epistemic goals and collective knowledge advancement as opposed to more personal epistemic goals (Scardamalia, 2002).

Metaphors for learning and knowledge creation

Acquisition and participation are two common metaphors for learning (Paavola Lipponen & Hakkarainen, 2004). Individuals are thought to construct their own pieces of knowledge in the acquisition process and the outcome is expected to demonstrate itself as a capability to apply this acquired knowledge in new situations.

Participation, on the other hand, is about taking part in social processes of knowledge construction in various cultural practices and shared learning activities. Knowledge does not reside in individual minds nor does it exist on its own. Knowledge is seen as an aspect of participation in specific cultural practices. Participation is situative with emphasis on durability of individual knowledge.

The distinction between acquisition and participation learning metaphors appears to be a matter of cognitive and situative perspectives of learning. Cognitive approaches emphasize computational models of mind, and the aim is to simulate the way the individual mind operates with knowledge. A cognitive perspective emphasizes *knowledge*, whereas situated approaches emphasize situatedness of human cognition, and participation in interactive, social processes as basic processes in learning. A situated approach emphasizes participation in social *practices* and *action.*

As a new metaphor of learning, knowledge creation dispenses with the dichotomy by emphasizing the process of acquisition rather than the outcomes, and participation in terms of the constant flux of knowing rather than having the knowledge (see table 1).

Table 1. Three models of innovative knowledge communities

	Nonaka & Takeuchi	Engeström	Bereiter
Type of processes focused on	Emphasis on the knowledge spiral, based on tacit versus explicit knowledge.	Emphasis on material object-oriented knowledge activities and practices.	Emphasis on knowledge building with conceptual artifacts.
Source of innovation	Transforming tacit knowledge into explicit knowledge.	Overcoming tensions, disturbances, and ambiguities through expansive learning.	Working deliberately to create and extend knowledge objects.
Scope of framework	Ontological levels (individual, group, organizational, and inter-organizational)	Activity systems and networks of activity systems.	Knowledge-building communities.

(Paavola et al., 2004 p.563)

Knowledge Forum

Knowledge Forum is a second generation CSCL environment that supports the learning of individual students by structuring the inquiry, providing tools for keeping a record of activities, and by pointing out essential phases of the process by using tools that direct the student's meta-cognitive awareness and enhance reflection (Pea, 1993). Knowledge Forum is distinguished from other learning management systems with its promotion of processes such as "defining problems and hypothesizing, researching and collecting information, analyzing and collaborating" (Knowledge Forum, 2007). Knowledge Forum, previously CSILE, has been in development over two decades with substantial research on how to use it to support collaborative work with knowledge (Scardamalia & Bereiter, 1994; Scardamalia, Bereiter, McLean, Swallow & Woodruff, 1989). Knowledge Forum database is completely generated by participants. Notes that are created online are stored as objectification of collective knowledge, which can be searched and reworked by others. Participants can also refer to other notes in the Forum that appear as links within the note, thus forming a visible web of incorporated ideas that mirrors the interwoven and dialogical nature of knowledge (see appendix A). Scaffolds, such as "I need to understand", "A better theory" point to the essential elements of inquiry and allow participants engage in an extended dialog with collectively accessible ideas rather than a mere dialog between minds (Bereiter & Scardamalia 1993).

Progressive inquiry

Muukkonen et al. (2005) devised a model of progressive inquiry as heuristic framework for epistemic advancement. Inquiry is a process of understanding driven by questions and includes certain epistemic elements. Progressive inquiry is based on shared expertise of the community which is enabled by supporting technologies, such as Knowledge Forum. Context is created for students to come up with their initial questions to get the inquiry started. Students set up initial research questions in an effort to satisfy their need to understand. Students are expected to use their own knowledge before consulting information sources and come up with some working theories. This process is likely to make students' intuitive conceptions visible and give them change to see the coherence of their thoughts in their effort to explain their ideas to others. The inquiry process continues with the critical evaluation the ideas for their weaknesses and strengths. Students often will refocus their inquiry by generating subordinate questions and learning more about these questions. The process is more likely to give way to new and improved working theories from this point on. Progressive inquiry can be conceived as an interrogative model of scientific inquiry that lends itself as an appropriate structure for distributed expertise among a community of learners and for the development of epistemic agency and related skills (Muukkonen et al., 2005).

Social Network Analysis

In a community of learners collaborating on advancing their collective knowledge their contributions have strong social components. Social network analysis offers several methods to investigate the flow of information within a group of people by abstracting a distance among them based on their contacts with each other. Each group member forms a node in the network with relational ties that get strengthened each time a member contacts another. The strength of these ties is conceptualized as a geodesic path between members. Some network indicators such as density, centrality and betweenness as well as individual qualities like in-degree and out-degree can be obtained (Wasserman & Faust, 1994).

Communities are formed through the accumulation of relations and influences among participants (Frank, 1998). Sharing and inquiring are two patterns of interaction used in this study. Social interactions of actors in the network were mostly commenting, collaborating, seeking for advice, mediating knowledge and providing social and emotional support. Access to knowledge and other resources is provided by structural context of relationship by means of links. Knowledge Forum is a networked learning environment that provides a shared space to the participants for producing, searching, classifying, commenting on, and linking knowledge together (Bereiter, 2002; Scardamalia & Bereiter, 1994).

Students who share and inquire further can be discerned in terms pursuing personal or collective epistemic goals and the degree of it may be interpreted as a degree of responsibly undertaken for collective knowledge advancement. The more students share their knowledge with more people and root for further inquiry with more people, the higher will be their epistemic agency. Social network analysis offers tools to analyze the density of such student interaction and show how central some of the members are in sharing knowledge and pushing for inquiry. Some members would be a channel, perhaps a broker, of information as more people do their knowledge sharing and inquiry through them (Hakkarainen & Palonen, 2003).

Knowledge Forum also offers some social network analysis tools for students to monitor various social aspects of their inquiry process. Reading contributions, referencing or improving on them via building on or adding annotations are readily analyzed as social contacts. Density of these contacts indicates whether the social contact is limited to among a few people or relatively dispersed among the community members.

METHODOLOGY

Students logged on the Knowledge Forum to read contributions written as notes and to create and/or revise their own notes and annotations. Student can either create a stand-alone new note or build on another note implying that this particular note is further work on the idea embedded in the note it builds on. Annotations, which are similar to sticky notes posted on objects, can be written by students in any number in any note. The first note of a view, which is a thematic organizer for notes, necessarily appears as a stand-alone note but students can also add a note in the same fashion to start a new line thought but such notes are not linked directly to another member. New notes that appear as stand-alone notes may either be meant for all to see or a creation of the author for various reasons. Such notes were not included in the analysis because they are not directly related to another member (see appendix A).

Students' written interaction as notes and annotations were analyzed to detect and rank those students in terms knowledge sharing, pressing on for further inquiry and the number of partners they communicated with. Student notes and annotations are relational because they can be interpreted as to be from one student to another. Social network analysis techniques and k-means clustering statistical tool were employed to rank students within each course in terms of their centrality using a betweenness value in the network, where higher values indicated more communication flow occurred through that person. An aggregate score is calculated for each student and they were ranked into four levels of epistemic agency ranging from exceptional to low.

Data collection

The data were collected over two summer courses taught one year apart with 23 and 21 students in each one where students exchanged 429 and 687 distinct written messages respectively online over a six week period, in addition to engaging in a similar verbal discourse three times a week for two consecutive 50 minute class meetings(see appendix B). Students worked on six problems of understanding about educational technology for the entire semester. Students in this study were of similar age and education with only gender as an evident demographic characteristic.

The course

Despite being thought a year apart, both courses were taught quite similarly. Students were introduced to knowledge building pedagogy and Knowledge Forum software at the beginning of the course. The instructor provided support on how to work with Knowledge Forum. A total of six problems of understanding, four about education and two about educational technology, were introduced in the first week of the course. Students were informed that they were expected to work on all six problems throughout the semester and their learning and understanding depended on their verbal and written contributions. Problem introductions were followed by students offering their ideas in their effort to understand and explain the problem in question.

Aligning assessment and learning with student goals in CSCL situations using electronic portfolios have been found to be a useful strategy (van Aalst & Chan, 2007; Erkunt, 2009). Students also prepared three portfolios using Knowledge Forum during course. They selected a number of best notes among all the notes organized thematically by the problems they worked on, explained how these notes affected their thoughts about the problem and they identified if and when a number of knowledge building principles were discernable in the notes selected based their collective process.

Knowledge Forum is designed to support and sustain idea improvement and makes the ideas and the process visible and workable with tools, such as scaffolds and referencing, to assist students in writing and reading contributions. (See the appendix A for a pictures of Knowledge Forum View, Note and Annotation, and appendix B for an exemplary discourse on "The good, the bad and the ugly" sides of technology problem).

Problems of understanding set the scene for the course because they were believed to be the sort of questions addressing the fundamentals of educational technology and inquiring about them would require students to get deeply into the subject matter and into relevant research in various domains (Bereiter, 2002). A computer in the class was used to access Knowledge Forum and project it on the screen. Students were asked to give their

impression of the course at the beginning, the middle and the end of the class. Here is how a student describes how the class was run[*]:

> *We start discussing about either one of the topics in Knowledge Forum or any other topic that happens to be talked at the moment. None of us is afraid of being criticized because no matter what one says, true or false, he will be criticized by all others in the class anyway. The criticism is never aimed for belittling or justification. The only aim is to be able to get the best possible understanding of what is said.*

Another student described the state of the mind in the course as follows:

> *In the beginning of this term I thought we would be expanding our horizons by discussing the topic during the term in a way we have never discussed before. It turned exactly the same way but I suffered in the process a lot more than I anticipated. Simply because, feeling the necessity to say something about the topics both in the class and in the (Knowledge) forum all the time catches one off guard even in some unexpected occasions as the mind gets busy with the problems. Now I see that this was how we constructed our knowledge.*

Another student depicted his experiences shortly after the end of the course about the knowledge building process as follows (the student alludes to entire knowledge building process by referring to Knowledge Forum):

> *Thinking is more of an involuntary action for me now. I already was a careful person and I paid attention to details wherever I was, intending on getting a deep understanding. But Knowledge Forum made that deeper… Perhaps we were already knowledge builders in life but we didn't know about it. This course made us aware, that's all. But writing about this to Knowledge Forum is definitely a product of this class.*

Coding

All the occasions of a member contacting another either via a build-on note or an annotation assumed to count towards the calculation of an outdegree score for that participant. All the written exchanges among the members were coded either as knowledge sharing (KS) or as attempts for distributed regulation inquiry (DRI) which means they have demanded further inquiry on a particular matter. Few notes that did not seem to be relevant to the context were excluded from the analysis. 30% of the notes and annotations were randomly chosen and independently rated by another person yielding a 70% Kappa value.

Most of the written student activity was about sharing what they presently knew and pressing on for further inquiry. Information provided as personal ideas or to support material usually in answering a question of declaring personal opinion on matters was coded as knowledge sharing (KS). Here is some knowledge sharing examples:

> *As social needs change what's worth learning will also change. Therefore things worth learning may differ among cultures and societies.*

> *I also think that technology is unavoidable but I disagree with the claim that technology may have lost purpose and gotten out of our control because technology does not get out of control. It exists to make people's lives easier and raise the quality of life. If people use technology for their own evil goals, however, that only shows that people are out control not technology.*

Distribution of regulative inquiry (DRI) is about clarifying meaning, spotting what is known and needs to be known as well stating that a satisfactory level has been reached in the inquiry. Here are some examples codes as DRI:

> *A very nice point of view, indeed. You question if "humanity was able to reach its expected humanistic goals by cars, trains or planes." Do you really think we use technology to reach those goals? Or what do you really mean by expected humanistic goals?*

> *What about things that we learn out of necessity, would they be considered automatic learning? For*

[*] Student quatations have been translated from Turkish with minor corrections leaving the rest intact.

example, is learning to get in line when waiting for a bus in the bus stop an automatic learning according to your theory?

RESULTS

Students were a mixture of junior and senior pre-service teachers in both courses majoring in English language teaching, primary and secondary science teaching and guidance and counseling. They took this educational technology course as an essential requirement of their programs. Their average age was 22.2.

The first course (G1) had twenty three students with twelve male and eleven female students. Students contributed 424 written pieces with 339 coded as KS and 85 as DRI. The second course had twenty three students of which fifteen were males and six were female who contributed a total of 687 pieces out of which 561 coded as KS and 126 as DRI.

30% of contributions of each course were randomly selected and independently coded which yielded an inter-rater reliability rating of r =.68 (p<.001).

Social network analysis techniques were employed for obtaining density and centrality measures. Density refers to the number of observed links (network ties) in a network divided by the possible number of connections (Borgatti, Everett, & Freeman, 1999, p. 78; Scott 1991, p. 74). Connections in binary matrices indicated either by 0 for no connection and by 1 for a connection. Knowledge Forum automatically calculates densities including various factors such as note reading and adding build-on notes. The combined density for build-on notes and annotations gives the relational network density for the group in term of contacting and contributing through others. The densities for G1 and G2 were 52.1 % and 51.7 % respectively. Densities in terms of knowledge sharing and regulation of distributed inquiry were also calculated using UCINET (Borgatti, Everett, & Freeman, 1996) by abstracting each such link as 1 and no link as 0. These adjusted densities for G1 and G2 respectively were 38% and 41.7% (table 2).

Table 2. Density values for each class

Combined density for build on notes and annotations		Density for knowledge sharing and distributed regulation of inquiry	
G1	G2	G1	G2
52.1 %	51.7 %	38%	41.7%.

Freeman's degree of centrality is a measure for network cohesion based on sent and received notes and annotations among members. A general centrality value was calculated that combined incoming and outgoing messages along with directional centrality values for incoming and outgoing messages. In symmetrical matrices all connections were abstracted as 1 whereas in asymmetrical matrices connections were treated as directional from one member to another. The general Freeman's centrality measure for G1 and G2 were found to be 22% and 30% respectively. The directional outdegree and indegree values for G1 were 16.8%, and 20%, and they were 41% and 31% for G2 (table 3).

Table 3. Freeman's centrality values for each class

General centrality value		Directional			
		G1		G2	
G1	G2	Out-degree	In-degree	Out-degree	In-degree
22%	30%	16.8%	20%	41%	31%

K-means cluster analysis is a statistical method for partitioning *n* number of observations into *k* number of clusters so that each observation belongs to a cluster nearest to its mean. In this study number of outgoing knowledge sharing and inquiry demanding contributions were calculated for each student to obtain scores of KS Outdegree and DRI Outdegree. If we think of students as a member of a network where information flows among them, Freeman's Betweenness value is score showing how often a student is in the path from one student to another. A Freeman's Betweenness score for each student both for KS and DRI were calculated. Finally the number students or partners students were in contact with were incorporated as the fifth score, which was taken to indicate how social a student was. A 4-means cluster analysis was performed to assemble student into four homogeneous groups (Hakkarainen & Palonen, 2003). Table 4 shows the cluster centers in 4-means cluster analysis. Appendix C shows all the data used in social network analysis for both groups.

Table 4. Cluster Centers for Relational Measures of Epistemic Agency

4-means cluster analysis	Level of Epistemic Agency							
Variables	Level 1		Level 2		Level 3		Level 4	
	G1	**G2**	**G1**	**G2**	**G1**	**G2**	**G1**	**G2**
Outdegree of knowledge-sharing comments	11	30	15	16	29	41	14	69
Outdegree of distributed regulation of inquiry	3	7	7	2	7	15	1	14
Betweenness of knowledge-sharing comments	20	19	24	4	66	16	70	42
Betweenness of distributed regulation of inquiry	7	20	63	2	55	48	0	63
Number of dialogue partners	10	13	15	7	17	14	11	17
Number of students	12	12	4	4	4	4	3	2

DISCUSSION

The results indicate that nearly half of the students in both courses were ranked in the lowest level of epistemic agency interpreted as following mostly their own epistemic goals with minimal knowledge sharing with few partners and mediating little of knowledge sharing and collective inquiry. There were two to three students in each course with outstanding score in all of the five criteria and the rest dispersed evenly from moderate to high.

Both courses gave a low network centrality value (Freeman) of 22% and 30% respectively, which indicate that communication was not concentrated over a few individual but evenly scattered among the members.

Cluster analysis was most revealing for the exceptional and strong levels of epistemic agency. Ideally, students with high values in the five criteria used for cluster analysis would be expected to rise to higher levels of epistemic agency. The higher F values in the cluster analysis indicate that centrality of the students in terms of knowledge sharing (KS) and distribution of regulative inquiry (DRI) were more effective in clustering. Therefore, cluster analysis is only used for clustering the group and not ranking among the clusters. Ranking is done in terms of combinatory ranking of each variable, namely number of partners, centrality of the student in KS and DRI, as well student's their Outdegree of KS and DRI (see table 3 for constructs used in ranking).

Outdegree of KS indicates how many contacts a student made in an attempt to share his knowledge with others. Outdegree of DRI, on the other hand, indicates how many contacts are made in an effort for further inquiry by a student. Freeman's Betweenness value indicates how central a student is in term of KS and DRI in the network.

Some discerning attributes of levels of epistemic agency are given below and compared in table 5.

- **Level 1:** They mainly advance their own knowledge with low knowledge sharing, few dialog partners, low mediation of knowledge and interaction (betweenness).
- **Level 2:** They assume some responsibility for others. Relatively higher knowledge sharing, more dialog partners and higher betweenness.
- **Level 3:** They assume considerable responsibility for knowledge advancement. They have high betweenness value, indicating systematic effort for other to go deeper and clearer in their explanations. They have high knowledge sharing and high number of dialog partners.
- **Level 4:** They have higher or the highest scores on knowledge sharing, distributed regulation of inquiry, number of partners and cognitive centrality.

Table 5. Epistemic Agency Levels

	1	2	3	4
Knowledge Sharing	Low	Moderate	High	Excellent
Mediation of Knowledge and Interaction	Low	Moderate	High	Excellent
Number of Dialog Partners	Low	Moderate	High	Excellent
Knowledge Advancement Goal	Personal	Some interest in nearby members	High collective responsibility	Exceptional

Even though this study conceptualized epistemic agency from the perspective of knowledge creation, it is still considered to be an individual quality that appears to be more of a collective nature. In other words, epistemic

agency is a relational phenomenon that emerges between people rather than within (Hakkarainen & Palonen, 2003) when active networking efforts of the students are taken into consideration. Hakkarainen and Palonen (2003) suggest that a sophisticated knowledge sharing approach is where epistemic agency shows itself, nevertheless distributed regulation of inquiry should probably count as much for it may very well indicate a desire to for deeper understanding even though it has more of personal tint than knowledge sharing.

Bereiter and Scardamalia (2008) suggest that five dimensions explain most of the pedagogical variety. One of them is the amount of direction in instruction where teachers set most of the learning goals, manages the process and appraise the outcome vs. students themselves doing more of the cognitive labor that are essential to understanding anything. Levels of epistemic agency depicted here seem to indicate how much of the cognitive responsibility is assumed by learners. Another dimension is variation of instructional focus from individual to collective. In this study, the instructor presented students with some fundamental problems of educational technology and encouraged students to engage in knowledge building discourse with students' ideas setting the agenda over an extended dialog in class and in Knowledge Forum. Students were instructed about and directed towards idea improvement. A few of them excelled in sharing and inquiring collectively, more than half settled for their individual goals and contacted only a few others with little to share and inquire about in writing. Some students ventured to write more than others. Some even got very good at it and became a conduit of information among the rest. Both courses had lively and inquisitive classroom discussions and students frequently complained that they find it hard to write their ideas even though they kept up with reading most of notes.

Epistemic agency is conceived in this study from a knowledge creation perspective of learning but the stronger forms are still an individual socio-cognitive quality and it is not necessarily a shared capacity as suggested by Damşa et al. (2009) that comes out when groups collaborate on creating knowledge objects. Epistemic agency is seen here as an individual quality which is mostly a function of epistemic goals, and as goals become collective the agency may shift to serve more for these collective goals.

Limitations of the study

This study is an attempt to identify epistemic agency an emergent construct among a community of learners interacting through written exchange of contributions towards advancing their knowledge. They have pursued individual and collective epistemic goals with an apparent mix of both in their effort to understand something. Knowledge Forum served as a public idea workspace. Some student contributions were posted as stand-alone notes that appear by itself in the Forum. These notes are excluded in the social network analysis because their lack of any relational ties to another member. Such stand alone contributions are presumably not posted for anyone in particular but for the poster himself. There seems to be not a useful way of including such stand-alone contributions at the moment as a social factor even though the researcher believes that it is most probably meant for all to see.

Another limitation is with the 4-means cluster analysis employed to group the means into four levels, but the resulting ranking was only reasonably descriptive for the high or exceptional epistemic agency. Low level categories did not match the construct qualities of betweenness, outdegree and number of partners. This situation is remedied by ranking of clusters based on the constructs assuming that freeman's betweenness values for knowledge sharing and pressing on for further inquiry were prominent attributes of epistemic agency. Therefore medium and lower epistemic agency ranking was modified accordingly.

Students in this study were engaged in a socio-cognitive effort to understand the problems presented in a collaborative environment by design. They participated in collective knowledge creation activity that is quite uncommon for school situations. The instructor/researcher has considerable experience to work with traditional students and helped them adapt to collective knowledge creation by designing and fostering a classroom culture that encourages collective work and a wide variety of ideas. Those students who ranked high in epistemic agency cannot clearly be discerned as whether they were knowledge builders or such a classroom environment made them shine such a quality. Despite the fact that epistemic agency is taken to be an emergent construct this study, the conditions that gave rise to it were not taken into account at all. Hakkarainen (2009) suggest that the knowledge building framework is not sufficient to turn out a knowledge creating community unless social practice of that community is also changed and supported. For descriptive purposes it should be added that a willful instructor with increasing experience in becoming a knowledge building teacher had taught these courses and constantly worked at keeping the ideas in the center, fought off the resistance to take over responsibility for learning both individually and collectively, set up and maintained an atmosphere of idea improvement despite early and strong personal tint in student arguments towards the bearer of the idea – a cultural factor no doubt for trust is valued attribute that is hard to gain and put the test constantly in this culture. The instructor put his effort to establish a knowledge practice and worked towards gradually shifting the epistemic agency more to the

students who almost invariably found his courses very different and strangely appealing in the beginning, surprised that their impressions were even asked to be heard in the first place, and generally ended up appreciating how valuable and fun was to think not only about things but about thinking as well.

Structural holes are conceptualized as barriers for network members the crossing of which will privilege that member with a competitive advantage simply because that member has access to weak ties in the network (Burt, 1995). Hakkarainen and Palonen (2003) suggested age and education as probably structural holes in group engaged in progressive inquiry. Students in this study were of similar age and education with only gender as a prominent demographic characteristics but that was not regarded as a barrier. Presumably students in this study may have had foreseen some benefit to being a prominent channel of information flow their community but the study did not incorporate any specific structural hole as a factor.

The role of the Knowledge Forum in this study is considered as an epistemic technology that "transforms students' intangible ideas into digital entities that can be further articulated, shared, interlinked, and extended in long-term processes" (Hakkarainen, 2009), a technology that embodies epistemic entities or artifacts that are still have a capacity for further and novel lines of inquiry because they are materially embodied and knowledge intensive objects. Nevertheless these epistemic objects give a sense of incompleteness that sets them apart from a thing like appearances of things and tools of daily life. Epistemic objects seem to be in a process of continually defined and redefined with more properties added in time and they are stand ins for the lack of more basic objects (Knorr-Cetina, 2001). Knowledge Forum gives them a more object like quality ideas can be represented as text, pictures and videos.

CONCLUSIONS

Epistemic agency as an emergent construct can be measured if the student contributions are classified as sharing or inquiry and using 4-means cluster analysis seems to be sufficient for classifying the degrees of epistemic agency. The ranking of the levels, however, is most healthily done from the construct as knowledge sharing betweenness score seem the most meaningful as an indicator of a channel or broker that links strong and as well as weak ties. Distribution of regulative inquiry is suggested as the second tier for ranking the epistemic agency because pressing on for further inquiry is essential for collective efforts. Outdegree value of knowledge sharing and inquiry ought to contribute close to each other. Number of partners is also quite significant in the sense that the wider the network links the more likely a member is to be a broker of knowledge crossing the structural holes.

The question is, of course, whether the study investigated is a meaningful categorization for epistemic agency. If the epistemic agency is the cognitive authority and responsibility for knowledge advancement (Scardamalia, 2002) and if it is more likely to show itself through knowledge sharing mainly because that is when students contribute to the advancement of the collective knowledge of the class, then the written communications could provide a good unit of analysis as students seem to spend considerable effort to write and compose their thoughts. Their efforts are directed at providing some kind of explanation about the general problem or a part of it as the content analysis for one of the groups for their object of inquiry shows it to be 73% explanation, 15% inquiring about the problem and 12% providing information (this analysis of object of inquiry was only performed for group one). Collective efforts are relational and knowledge building is a collective endeavor where social network analysis seems like an appropriate tool for measuring relational ties. Ideally density of a social network is a good measure for the amount of contacts in a group especially in writing which could be dispersed longer time frames. Freeman's centrality is very useful for showing the concentration of contacts, which should be not be to high if the knowledge creation effort is dispersed among the members. Freeman's Betweenness value, on the other hand, shows how many times a member appears in the path between other two members and is quite relevant for epistemic agency as Hakkarainen and Palonen (2003) suggest because higher scores mean that member being a channel between other members as they share and inquire. Higher betweenness may bring an advantage to a member as he is more likely to learn about new knowledge that will contribute to innovations concerning the problem at hand. Structural holes may be more apparent factor in more heterogeneous group engaged in collaboration.

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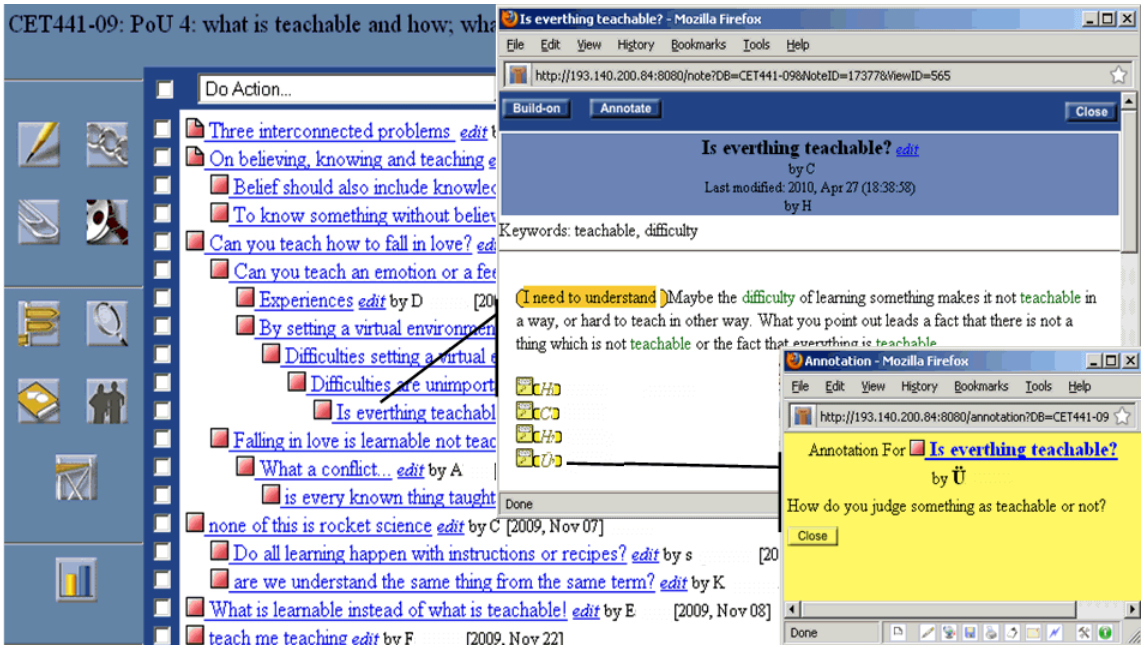
APPENDIX A. Knowledge Forum, notes and annotations



APPENDIX B. A section of inquiry reproduced from Knowledge Forum

This particular piece of discussion took place within last ten days of the intense summer course. Names are left as initials and indentations indicate they are build-on notes. Italicized text within bolded brackets are the scaffolds used by the students. Underlined texts between the parentheses are the clickable references for other notes in the database. The text blocks in italics are the annotations made in the immediate note above. These notes have been translated from Turkish with minor corrections leaving the rest intact.

Instructor

Problem of understanding: The good, the bad and the ugly.

It appears that technology, whatever that is, creates just as many, if not more, problems than it intends to solve.
Besides the aforementioned paradox, technology is also attributed an agency; an entity that can create a difference by itself. This could be a misunderstanding language may be forcing on us, but maybe there is some truth to it.
Moreover, technology is thought of as value-free; good with the good and bad with the bad. Is that really so?

Last 10 days of a 35 day period

.....

F. K.

Even if what I said is true, mine is not the only truth. [2009, Jul 24]

[*My Theory***]** It seems we are stuck with certain ideas in this discussion: "technology is good itself but we misuse it", technology is out of control not us, "technology has side effects", technology serves capitalism, "the problem is out of our hands and technology does not make you lazy" etc… All of them have some valid points. That is, they all can be considered right from a certain point of view. Our problem, however, is over generalizing. We seem to think only of telephone, TV, computers, weapons and such when thinking of technology. If we could only think about drugs that heal, homes we live, drinking water in Japan, clothes we wear and foods we consume as technology as well, then perhaps we can judge technology better. Therefore, all of the above points of view can claim that they are right, unless it is really obvious, but no one can say that only theirs is the truth.

F. C. **I can't decide [2009, Jul 25]**

[*Putting our knowledge together***]** Even if I agree with him (Even if what I said is true, mine is not the only truth) that a few examples aren't sufficient to show whether technology is good or bad, just claiming either way does not necessarily make technology good or bad. The opposite could also be true. Thus it seems difficult make a definitive judgment.

T. P. **Definitive?? [2009, Jul 26]**

I don't think our discussion here is about making definitive judgments. Obviously a topic with clear-cut answers would not naturally come up in this course. I see nothing wrong with everyone making up their own minds. 90% of our lives exclude any sort of definitive judgment. Let it be same here.

M. K. **The good is here but can't find the ugly anywhere. [2009, Jul 28]**

[*This theory cannot explain***]** Is this the point of this discussion? None of the notes here claims to be the only truth, and our friend who started this discussion says it isn't so here (Definitive??). We are just trying to question the ideas so that we can better see the good, bad and ugly sides of technology. This effort expands our minds and prepares us for persuading others about or refuting the new ideas. We can continue our discussion outside the class 7/24 and that is the good side of technology. The bad side, on the other hand, is that writing this note leaves me with a stiff neck and bloody eyes late at night. I can't decide about the ugly side yet. Should we wait for someone to offer their only truth?

G. P. **Could this be the ugly side? [2009, Jul 29]**

[*A better theory***]** Perhaps we can consider our case of not accessing to Knowledge Forum yesterday due to a technical problem as its ugly side. Technology failed all of us. Our technological Knowledge Forum was interrupted because of technology.

F. K. **This may be more of disadvantage than the ugly side. [2009, Jul 30]**

[*Different opinion***]** It may result in bad consequences but we may not be able to generalize from it. The real problem appears to be our unconditional dependency on Knowledge Forum. We should prepare ourselves for such occurrences if we all accept this system with its good and bad sides. This is similar to services of a government agency coming to a halt due to technical problems. Since we are not going to give up Knowledge Forum just for this, we must therefore be prepared and have alternative solutions.

F. C. **I don't think so [2009, Jul 31]**

[*Putting our knowledge together***]** As a friend points out here (Could this be the ugly side?) I don't think such a technical foul up can be regarded as ugly because all the good and useful things may have imperfections. And it was a temporary problem and was fixed quickly.

T. S. **No offence but there is an ugly side. [2009, Aug 01]**

[*I need to understand***]** Luckily we were back on quickly in our case (This may be more of disadvantage than the ugly side) but what if the problem was prolonged, say, a government system was down a long time thereby disrupting many necessary and vital

functions only because they were dependent on computers, would we still not call it the ugly side? What if, for example, we need a print out for a course project written only in computers just before it is due only to find out that our work is all damaged beyond recognition when it last saved. We would have nothing. Can we still not claim this as the ugly side of technology?

G. P. **This would be the ugliest. [2009, Aug 02]**

[*Putting our knowledge together***]** As our friend says in the note (No offence but there is an ugly side) the ugly side reveals itself much better when we expand the situation outside our course, because it scary even just to think about how our lives would have been paralyzed if all the information in the cyberspace evaporated due to technical problems.

F. K. **Points of view. [2009, Jul 30]**

[*Putting our knowledge together***]** In fact, as I have said before, we won't be able to make definitive judgments about technology such as it being good for certain things therefore indispensable or it being harmful one way of another thus should be dropped immediately. Nevertheless, as you also wrote in this note (The good is here but can't find the ugly anywhere), here we learn about alternative ideas and develop various points of view. I think that the beautiful and the ugly sides of technology will remain relative to the person except for, perhaps, some obvious cases. As I also mention in my course impressions, not only we have learned quite a few new things in this process but also we developed lots of different skills. I think this turned out to be very good.

S. K. **If we were to summarize it all… [2009, Aug 03**

[*My Theory***]** I don't understand humans. First they invent bullet-proof vest and then comes the bullet that penetrates that vest. I think we have to consider technology from this perspective as well: it is a field that progresses by disproving itself. Newest innovation discards the previous one. We are engulfed in pollution and chaos. Of course, we humans are the ones doing it. I think we are now well beyond seeking the useful but rather pursue the fantastic. I think the problem that is source of our problems.

M. P. *Dear S. K.. Don't you think that now we see this situation as normal? They even show the pollution as innovation. It is true that it a field progressing by disproving itself and for now any other solution is not in sight, but just for now. I am hopeful for the future :)*

O. A. *I think it is quite normal for humans to discard the older technologies and replace it with new ones. I don't think we should call it neither pollution nor chaos. This is how technology got started: it aims for continuous progress, for the highest peaks*

M. P. *It true that we are in continuous progress in the field of technology but it is also quite clear that we will stumble upon the hole we dug in this very progress. No need to empty the world in the name of progress (I refrain from using harsher terms here since we are in a virtual environment). We have to be more careful with our steps*

APPENDIX C. Data used in social network analysis for both groups

		Size of network				Knowledge-sharing network				Distributed regulation of inquiry				Levels of epistemic agency	
ID		Dialog partners		Indegree		Out-degree		Between-ness		Out-degree		Between-ness			
G1	**G2**	**G1**	**G2**	**G1**	**G2**	**G1**	**G2**	**G1**	**G2**	**G1**	**G2**	**G1**	**G2**	**G1**	**G2**
01m	01m	18	4	17	11	21	5	48	12	7	1	33	0	2	1
02f	02m	19	4	41	4	31	7	76	0	13	3	61	0	4	1
03m	03f	20	4	27	7	42	6	55	2	2	3	60	7	4	1
04m	04f	15	9	15	7	5	16	19	5	15	3	22	6	1	1
05f	05f	11	7	18	7	9	10	16	0	4	2	1	0	1	1
06m	06m	12	12	9	27	24	30	18	11	0	3	0	9	2	2
07f	07m	18	7	18	7	14	18	11	4	13	0	58	0	3	1
08f	08f	16	2	17	4	17	3	25	0	2	1	11	3	2	1
09m	09f	11	15	12	51	20	64	29	49	5	17	20	76	2	4
10m	10f	17	0	28	2	29	24	37	0	8	3	55	0	4	1
11f	11m	12	11	16	30	19	24	64	15	2	3	0	2	2	1
12m	12m	10	18	8	66	12	74	62	34	1	10	0	50	1	4
13m	13m	12	16	4	32	12	40	23	14	4	9	30	27	3	2
14m	14m	10	0	5	10	10	11	86	0	1	1	1	0	1	1
15f	15m	8	13	7	6	15	31	31	4	2	3	0	0	1	1
16f	16m	12	14	8	40	3	45	15	19	3	11	0	41	1	3
17f	17m	7	17	2	16	14	23	0	5	2	6	0	3	1	1
18m	18m	12	10	8	15	23	24	85	3	5	2	65	0	2	3
19f	19m	17	16	22	44	7	31	24	12	1	27	62	59	3	3
20f	20m	8	12	6	47	7	48	43	17	1	6	0	45	1	3
21m	21m	7	15	3	39	9	35	24	18	4	12	79	23	1	2
22m	-	6	-	4	-	4	-	20	-	0	-	0	-	1	-
23m	-	5	-	1	-	5	-	1	-	1	-	0	-	1	-