Exploring the Potential of a Handheld Participatory Simulation and Social Network Application for Revealing Decision-Making Processes for Information Seeking Amongst Middle School Students

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Abstract: In this study a participatory simulation called the *Discussion Game* combined with TeCFlow, a temporal social networks visualization program is used to identify socially and cognitively-oriented rules for selecting discussion partners. Whereas, the majority of rules for previous interactions are based on social or random factors, after studying social network graphs, students cite more cognitive or informational factors as reasons for who to talk to.

Theoretical Considerations and Research Focus

Recent research on networked handheld applications has focused on how they can be used to influence the development of core CSCL skills and processes such as inquiry, collaboration, communication, decision-making, motivation, engagement, assessment, and information access (Clyde, 2004; Colella, 2000; Klopfer et al., 2004; Klopfer et al., 2005; Relan et al., 2003; Yoon, in press; Zurita & Nussbaum, 2004). Research on a subset of handheld applications called participatory simulations (Klopfer et al., 2005) that embed students in face-to-face simulations of complex events have been particularly valuable in demonstrating how technological affordances can be leveraged to support the acquisition of complex problem-solving skills such as multiple perspective taking (Yoon, in press). Social network analytic tools have also been used to promote CSCL processes although applications of this sort have been relatively fewer in education. Gloor (2006) found that by applying social network analyses to their own online communication patterns in a university course, students were able to improve communication behavior in virtual group activities. The exploratory work reported in this study aims at understanding the educational potential for an intervention that uses a handheld participatory simulation and social network application to reveal decision-making rules about who students want to talk to in order to share and gain information about a new science topic. It follows from previous research results (Yoon, in press) that demonstrated, amongst other things, that visual feedback of individual opinions on a topic, provided middle school students with information about their relative position in the classroom network and who they wanted to discuss their opinions with. The specific goals for this study are: 1) to investigate what participatory simulations coupled with social network analyses reveal about students' decision-making processes; and 2) to investigate how students use information gleaned from social network graphs to make peer selections.

The handheld participatory simulation used in the study is called the *Discussion Game* (Yoon, in press). In this game, participants are asked to rate an issue on a Likert-scale from -5 (completely unacceptable) to +5 (completely acceptable) and provide a rationale for their rating. Participants are required to exchange their ratings and rationales with other participants via the infrared *meet* function on the handheld and are asked to hold discussions with each other about their positions. After discussions, participants are encouraged to reflect on what they heard and change their positions. Interactions are archived on each handheld and collectively uploaded to a social networks visualization software program called TeCFlow which computes the information and provides a visual graph of the communication network created from the game.

Methodology

Volunteers for the study were recruited from two urban middle schools in West Philadelphia. The program was advertised as an intensive academic camp held over two weeks during the summer, with a curricular focus on cell biology and genetic engineering. Nine females and six males participated. All students were African American, eight students from one middle school and seven from the other and all scheduled to attend grade 8 in the fall of 2006. The study took place over 10 days in a two-week, 40 hours of instruction time frame in August 2006. Students explored a number of teacher-selected and student-selected multimedia and print materials that presented information on genetic engineering of animals and plants. Curricular concepts covered from the School District of Philadelphia's grade 8 core curriculum were DNA, chromosomes, genes, sexual and asexual reproduction, and mitotic and meiotic cell division. Throughout the program, students were asked to reflect on information learned about the effects of current genetic engineering research on human and non-human species. Five *Discussion Games* were played over the course of the intervention. The specific question addressed in the game was: *Genetic*

engineering research and applications are acceptable. The data reported here were obtained from the five social network graphs generated from the games and responses from three questions taken from a social networks survey administered during the latter half of the program (on the seventh day of the ten day program): 1) Who have you spoken to most consistently over time and why?; 2) What are the rules by which you make choices about who you want to talk to?; and 3) Look at the last graph. Who on the last graph would you like to talk to most in the next game and why? Themes and categories were discussed and negotiated amongst the researcher and a graduate assistant and 98% interrater reliability was obtained from two independent raters.

Results

Students identified five rules by which they made choices about who to talk to in the *Discussion Game*. In some cases, students identified more than one rule. Table 1 shows the rule and frequency in student responses.

Table 1: Rules by which students made choices and frequency of responses.

Rule	Frequency
Talked to friends or people I was familiar with	7
Random, no rules, talked to anyone who was available	6
Talked to people who had a different rating than mine	4
Talked to people who had a similar rating to mine	1
Talked to people who had the most information	1

As shown in Table 1, the predominant rule by which students made choices about who to talk to was based on familiarity or friendship prior to studying the graph of interactions. As a cross check, responses from students about who they talked to most consistently over time and why produced similar findings in that 9 out of the 15 students identified a friend or person from their school. It should be noted that this pattern of choice was anecdotally observed to be fairly consistent over the first six days of the program prior to administering the survey and students were continually instructed to make decisions about who to talk to based on selection criteria other than friendship. Despite these instructions, only one student followed the rule of choosing people who had the most information. This student wrote, "The rules I went by are people who had the most important facts because it keeps my mind changing." Although the set of rationales produced to support student ratings is yet to be analyzed, anecdotally, this student showed the greatest growth in conceptual understanding as well as the most balanced evidence-based perspective by the end of the program.

Student responses to the third survey question about who on the last graph they wanted to talk to most and why, provided more encouraging results. After reading the graph (Figure 1), 12 out of the 15 students indicated that they wanted to talk to Chris (who had a rating of 5) in the next round and 2 out of the 15 wanted to talk to Jamie (who had a rating of -5). The remaining student Chris himself wanted to talk to Jamie. Figure 1 shows that by the seventh day, most students were selecting ratings in the middle range. Thus, selecting students who had ratings vastly different than their own appears to represent a shift in their selection strategies. Reasons given for their selections fall into the four categories outlined in Table 2. Comparing rules and reasons provided in Table 1 and 2, it appears that students based their selections on different criteria. Whereas, the majority of rules for previous interactions were based on social or random factors, after studying the social network graph, students cited what could be understood as more cognitive or informational factors as reasons for who to talk to.

Table 2: Reasons given for who students wanted to talk to after reading the graph.

Reason	Frequency
Want to understand why their ratings are different	7
Want to convince the person	5
No reason given	2
Want to be convinced by the person	1

Discussion

The pattern of choosing friends, also known as homophily, is a particularly robust finding in studies of social networks of adolescents and has been shown to produce detrimental effects, for example, with respect to

harmful substance use (Ennet et al., 2006), emotional and behavior disorders (Farmer & Hollowell, 1994), and academic effort and choice (Frank et al., 2005). Frank (1999) discusses two fundamental principles of social psychology that link interactions of actors in networks to their decisions or rationales for choice. The first principle describes choices being made based on the need to think and behave like others around them. The second principle describes choices based on informational or knowledge needs. Others have discussed similar dual categories of decision-making processes that compare socially-oriented selection pressures to cognitively or conceptually-oriented selection pressures such as content vs. non-content bias (Gil-White, 2004); practical problem-solving vs. norm adoption and identity membership (Castlefranchi, 2001); and memetic or copying mechanisms vs. non-memetic mechanisms (Dennett, 1995). Stanovich (2004) states that such processes can be described in terms of reflective vs. non-reflective selection. In any case, the implications for educational contexts are clear in that the latter of the dichotomies ought to be the primary focus for school and learning in order to challenge the potentially detrimental effects that social mechanisms can have on students. This study aimed at investigating what participatory simulations coupled with social network analyses could reveal about students' decision-making processes and how students use information from social network graphs to make decisions. It has been demonstrated that information contained within social network graphs can be used by teachers to trigger more cognitively-oriented selection rules or strategies. As previously noted, further analyses are yet to be completed with the content of student rationales and discussions produced by the *Discussion Game* in which further support for the use of participatory simulations and social network analyses in educational domains is expected.

References

Castelfranci, C. (2001). Towards a cognitive memetics: Socio-cognitive mechanisms for memes selection and spreading. Journal of Memetics - Evolutionary Models of Information Transmission, *5*, 1-14.

Clyde, L. (2004). Computing in the palm of your hand. *Teacher Librarian*, *31*(3), 42-44.

Colella, V. (2000). Participatory simulations: Building collaborative understanding through immersive dynamic modeling. *The Journal of the Learning Sciences*, *9*(4), 471-500.

Dennett, D. (1995). Darwin's Dangerous Idea. New York: Simon & Schuster.

Ennett, S.T., Bauman, K.E., Hussong, A., Faris, R., Foshee, V.A., and Cai, L. (2006) The peer context of adolescent substance use: Findings from social network analysis. *Journal of Research on Adolescence*, *16*(2), 159-186.

Farmer, T.W. & Hollowell, J.H. (1994). Social networks in mainstream classrooms: Social affiliations and behavioral characteristics of students with EBD. *Journal of Emotional & Behavioral Disorders*, *2*(3), 143-163.

Frank, K.A. (1999) Organization culture as a complex system: Balance and information in models of influence and selection. *Organization Science*, *10*(3), 253-277.

Frank, K.A., Muller, C. & Schiller, K. (2005, August). *The social milieus of adolescent society and their implications for academic effort*. Paper presented at the Annual Meeting of the American Sociological Association. Philadelphia, PA.

Gil-White, F. J. (2004). Common misunderstandings of memes (and genes): The promise and the limits of the genetic analogy to cultural transmission processes. In S. Hurley and N. Chapter (Eds.). *Perspectives on Imitation: From Cognitive Neuroscience to Social Science.* Cambridge: MIT Press.

Gloor, P., Paasviaara, M., Schoder, D. & Willems, P. (2006, September). *Correlating performance with social network structure through teaching social network analysis*. Paper presented at the Proc. Pro-Ve 06, 7th IFIP Conference on Working Enterprises, Helsinki, Finland.

Klopfer, E., Yoon, S. & Rivas, L. (2004). Comparative analysis of Palm and wearable computers for Participatory Simulations. *Journal of Computer Assisted Learning*, *20*, 347-359.

Relan, A., Guiton, G., Parker, N. & Wilkerson, L. (2003, April). *A hand-held requirement for clinical education: Effectiveness of a systemic educational intervention in altering perception and use of handhelds among medical students*. Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL.

Stanovich, K. (2004). *The Robot's Rebellion*. Chicago: The University of Chicago Press.

Yoon, A. (in press). An evolutionary approach to harnessing complex systems thinking in the science and technology classroom. To appear in the *International Journal of Science Education*.

Zurita, G. & Nussbaum, M. (2004). Computer supported collaborative learning using wirelessly interconnected handheld computers. *Computers & Education*, *42*, 289-314.