Fostering Information Strategies Through Visualization of Networks

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Abstract: This study hypothesizes that when social network graphs are used in instruction, students are presented with otherwise hidden information that can be used to make more strategic decisions about who to interact with in discursive activities. 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 reasons.

Introduction and Theoretical Considerations

Studies have shown that students lack basic understanding of central systems ideas, such as decentralization and control (Resnick & Wilensky, 1998; Yoon, 2007) and complex causal explanations (Grotzer, 2005). Researchers have speculated that difficulties, in part, lie in students' inabilities to understand mechanisms that drive the emergence of macro-level phenomenon from more micro-levels of interacting agents (Chi, 2001). Often this confusion of levels results from difficulties in recognizing that real-world phenomena exist at multiple levels of space and time. Computational applications such as *StarLogo, NetLogo, Biologica, and Participatory Simulations* (Gobert, 2005, Klopfer et al., 2005; Resnick, 1994; Wilensky & Reisman, 2006) that enable visualization of varying states of order and structure in complex systems have shown promising learning gains. Although fewer educational technology applications have been constructed for learning about socioscientific issues, increased learning effects have also been demonstrated through curricular interventions premised on the ability to visualize multiple perspectives and decision-making processes in networked interactions (Yoon, 2007). This study hypothesizes that when social network graphs are used in instruction, students are presented with otherwise hidden information that can be used to make more strategic decisions about who to interact with in discursive activities.

Social Network Application and Participants

A handheld participatory simulation called the *Discussion Game* (Yoon, 2007) was used in this study. In this game participants are asked to rate a controversial statement and provide a rationale for their rating. Participants exchange their ratings and rationales on the handheld with other participants and hold discussions with each other. Participants 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. Students from two grade 7 classes in two urban West Philadelphia schools participated in the study during the summer and fall of 2006. 36 students in total participated, 16 males and 20 females. The study engaged students in learning activities that encompassed 40 hours of instruction on the topic of genetic engineering. 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 two questions taken from a social networks survey: 1) What are the rules by which you make choices about who you want to talk to?; and 2) Look at the last graph. Who on the last graph would you like to talk to most in the next game and why? All categories were negotiated amongst the researcher and a graduate assistant. 98% interrater reliability was obtained from two independent graduate assistants.

Results

Table 1 shows the rules, frequencies of responses and relative percentages students indicated in their social network surveys before and after studying the 5 social network graphs. In the first half of the table, the total number of rules given reflects the fact that students offered more than one rule before studying the graphs whereas, after studying the graphs, each student only offered one strategic rule. Comparing before and after conditions of the total responses in the before condition, 63.2% belonged in the *random, no rules, talked to anyone available*, *similar rating to mine* and *friends or familiar people* categories. These categories can be thought of as non-content, social rules. However, in the after condition, this percentage decreased to 13.9% with no students identifying friends as people to talk to. Rules selected in the *different rating than mine,* and *most information, best argument* categories in the before condition represented 36.8% of responses. In the after condition, 86.1% of responses occupied the categories of *want to understand rating and rationale, least like mine, want to convince them, and strong argument, want to be convinced*. These categories can be thought of as content or information-based rules.

Table 1: Rules, frequencies and percentages by which students made choices before and after studying graphs.

Rules *Before* Studying Social Network Graphs	**Freq.**	**%**	**Rules *After* Studying Social Network Graphs**	**Freq.**	**%**
Random, no rules, talked to anyone available	14	24.6	Want to understand rating and rationale	19	52.8
Different rating than mine	14	24.6	Least like mine, want to convince them	8	22.2
Similar rating to mine	11	19.3	Strong argument, want to be convinced	4	11.1
Friends or familiar people	11	19.3	No rules	3	8.3
Most information, best argument	7	12.3	Similar rating to mine	2	5.6
Totals	57	100	Totals	36	100

Discussion

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 terms of the study's hypothesis, social networks graphs appear to have provided information to students that fueled the selection of more strategic rules increasing the likelihood that content or information-based strategies were chosen for navigating the learning system.

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.

Chi, M. (2001, April). *Why Do Students Fail to Understand Complex Dynamic Type of Concepts*? Paper presented at the annual meeting of the American Educational Research Association, Seattle, WA.

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

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.

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.

Gobert, J. (2005). Leveraging technology and cognitive theory on visualization to promote students' science learning. In *Visualization in Science Education*, J. Gilbert (Ed.), pp. 73-90. Springer-Verlag Publishers, Dordrecht, The Netherlands.

Grotzer, T. (2005). Role of complex causal models in students' understanding of science. *Studies in Science Education, 41*, 117-166.

Klopfer, E. Yoon, S. & Perry, J. (2005). Using palm technology in Participatory Simulations of complex systems: A new take on ubiquitous and accessible mobile computing. *Journal of Science Education and Technology*, *14*(3), 285-298.

Resnick, M. (1994). Turtles, Termites, and Traffic Jams. Cambridge, MA: MIT Press.

Resnick, M. & Wilensky, U. (1998). Diving into complexity: Developing probabilistic decentralized thinking through role-playing activities. *Journal of the Learning Sciences, 7*(2), 153-171.

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

Wilensky, U., & Reisman, K. (2006). Thinking like a wolf, a sheep or a firefly: Learning biology through constructing and testing computational theories. *Cognition & Instruction, 24*, 171-209.

Yoon, S. (2008). An evolutionary approach to harnessing complex systems thinking in the science and technology classroom. *International Journal of Science Education*. 30(1), 1-32.

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