Adding Time to Social Networks: A New Perspective on Using Learning Analytics for Learning Environment Design

Yang Xu, Boston College, yang.xu.3@bc.edu

Abstract: This study shows dynamic network analysis extracts additional insights into student-teacher interactions in learning environments from large-scale behavior data. Taking a design research perspective, this study examines how 323 students and 9 teachers read each other's written compositions in an online literacy environment. The analysis reveals longitudinal differences in the social dynamics between students and teachers in different classrooms demonstrates how inclusion of teachers completes the picture of learning design and implementation in CSCL research.

Keywords: dynamic social network analysis, learning environment design, design-based research, classroom interaction

Introduction

Social network analysis (SNA) is especially relevant in CSCL research. It provides both easily interpretable visualizations of the interactions between learners with sociograms and quantitative measures of the different roles learners play and the nature of social interactions (Hernandéz-García et al., 2015). However, SNA provides merely a fragmented snapshot or an aggregated view of the social interactions (Kolaczyk, 2009), without examining how these interactions change over time: new relationships could be established, old connections might dissolve, and the power dynamics could change. With time as an additional dimension, dynamic/temporal social networks can capture these changes, which helps us understand more about how socially-enabled learning environments work.

The purpose of this study is to explore whether the descriptive analysis of dynamic/temporal social networks can be effective in extracting useful insights on the use of one specific feature of an integrated online literacy environment called Udio. With the Universal Design of Learning (UDL; Rose, 2000) as its guideline, Udio is an online literacy platform designed to longitudinally improve the reading and writing skills of all learners with rich supports, such as built-in dictionaries and Text-to-Speech (TTS) Engines. To support the development of writing skills, Udio allows users to create "projects," short texts combining snippets of texts and images from Udio articles as well as writings and drawings based on users' own understanding of the texts, which can be shared with other Udio users from the same classroom. The focus of this study is to discover the extent to which the projects were read by the others after being published by Udio users. It assumes a design-based research (DBR) perspective (Barab, 2014; Barab & Squire, 2004) and uses the information gained through dynamic network analysis to reflect on the design of Udio. The research questions are:

- Was the "Read Project" function frequently used by students and teachers in Udio?
- How did the usage of the "Read Project" function change over time?
- How did the usage of the "Read Project" function over time vary across different classrooms?

Dynamic Social Network Analysis

323 students and 9 teachers from 7 middle schools across the US consented to participate in the study in the 2014-15 academic year. Although some demographic information is missing, this sample represents a fairly heterogeneous group with more male (190) than female (120) students. Approximately 81 students have IEP statuses, 68 are ELLs, and 211 are on Free or Reduced Lunch Plans.

Udio's event logs, which store over 600,000 user behavioral data logged between November 2014 and July 2015, were used to construct the dynamic social network. The network is visualized in Figure 1. Each node in the network represents either a student or a teacher in Udio. The color of the node indicates which class a Udio user belongs to, and only the teachers are labeled. Each edge is defined as the direction and frequency of the "Read Project" behavior: if User A read B's project, an edge (arrow) is defined pointing from A to B, with its weight (thickness) being the "frequency" of such visits taking place. The "frequency" of visits is defined as numbers of "valid clicks", visits lasting more than 20 seconds, a reasonable amount of time for a typical middle school students in the sample to read most projects. Noisy records such as visits originating from refreshing the browser and visits to each user's own projects (loops) were excluded. Each edge, upon creation, stays in the network, while each further visit between the same source-target pair adds to the weights of the edges.

Results

The first two research questions can be answered with Figure 1. Although the overall network is sparse with low density and about 20% disconnected nodes, the out-degree distribution suggests highly varied levels of use across users and different classrooms, and assortativity coefficients reveal no specical patterns for IEP or ELL students. Temporal changes revealed "late-comers" – some classes did not start using this function until late in the Spring semester. Most interestingly, teachers played completely different roles in this network: one teacher read other students' projects close over 400 times, while three others did not use this function at all.

To answer the third research question, I chose three largest components of the overall network, named them Classes 1-3, visualized them individually, and examined the growth of student-student, teacher-student, and student-teacher project visits over time (Figure 2). Class 1 is a typical star-shape network with the teacher playing a central role. In this class, the teacher visited students' projects more than all student-student project visits combined. The growth of student-student visits also corresponds with teacher-students, suggesting a usage pattern prompted by the teacher. In Classes 2 and 3, however, project visits seem to be more voluntary, and the growth is steadier than that in Class 1. In all three classes, the common pattern follows an initial surge succeeded by a level-off in the Spring semester and another surge in June 2015.

Conclusion

Dynamic SNA reveals not only topological but also temporal patterns in how the individuals in the network interact with each other. Specifically, this study highlights the key role teachers play in enacting the design of computer-supported collaborative learning environments, which enables learning environment designers to ask further questions about what perceptual and design factors led to these differences, to what extent these differences should be allowed, and the effects of these differences on learning. This suggests one analytical approach to large-scale behavior data that can be used to improve learning environment design.

References

Barab, S., & Squire, K. (2004). Design-Based Research: Putting a Stake in the Ground. *Journal of the Learning Sciences*, *13*(1), 1–14.

Barab, S. (2014). Design-based research: A methodological toolkit for engineering change. In R. K. Sawyer. (Ed.), *The Cambridge handbook of the learning sciences* (2nd ed., pp. 151-170). New York, NY: Cambridge University Press.

Hernández-García, Á., González-González, I., Jiménez-Zarco, A. I., & Chaparro-Peláez, J. (2015). Applying social learning analytics to message boards in online distance learning: A case study. *Computers in Human Behavior*, 47, 68–80.

Kolaczyk, E. D., & Csárdi, G. (2014). Statistical analysis of network data with R. New York: Springer.

Rose, D. (2000). Universal design for learning. Journal of Special Education Technology, 15(1), 67.

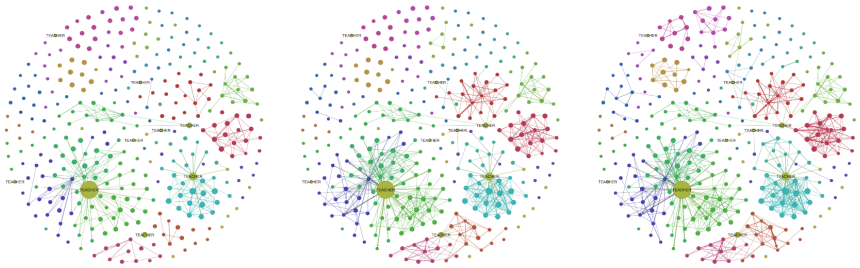

Figure 1. Visualization of overall network as of January, March, and May 2015.

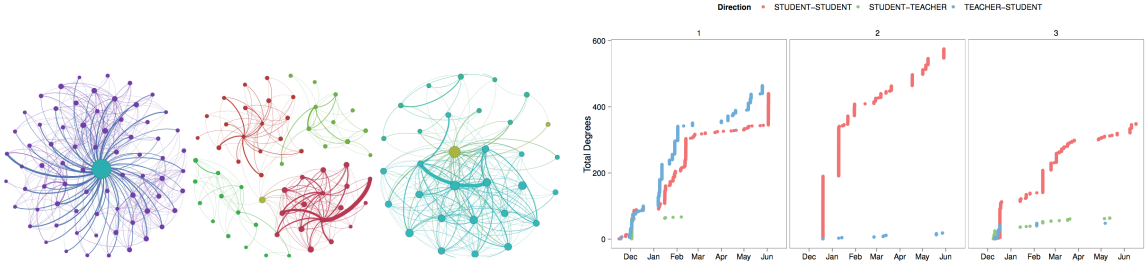

Figure 2. Visualization and growth of out-degrees in Classes 1-3.