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Online learning and the evaluation of group processes

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Abstract

The current rapid increase in online classes using learning community approaches and the emergence of learning communities in knowledge economy businesses has created an awareness that little is known about the group dynamics that allow learning communities to succeed or fail.

In recent years, an innovative *network science* approach to the understanding of group processes has evolved. This approach allows the discovery of patterns among group interactions. The *Knowledge Forum* knowledge building environment has a suite of online tools for tracking students' interactions with the environment, and these interactions are analyzed using network analysis techniques.

In a study of a Gr. 5/6 hybrid class, it was found that a network analysis of note reading showed a very high note reading density of 92%, that building-on was much lower at 15%, and that note contribution rates showed a linear trend. Sociograms are used as a network visualization tool, including both 2-D and 3-D network visualizations. Interpreting these data in light of the instructor's knowledge of the class can yield useful data about student performance within the group.

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Introduction

Online education has become one of the most important forces in education in recent years. With many viewing that traditional schooling approaches are obsolete (Gates, 2005; Gelernter, 2002; McCain & Jukes, 2001; Sterling, 2002), there is an increasing realization that online courses offer many advantages over traditional courses (Brody, 2005; Kassop, 2003; Pope, 2006) and may provide a way ahead for the 21st century. A recent survey from the United States reveals that online education in the U.S. had 2.35 million students in 2004 and is growing at a rate of 18.6% per year – ten times the projected rate (Allen & Seaman, 2005). Online education is experiencing similar growth in Europe (Paulsen, 2003) and Australia (Bell *et al.*, 2002). As a result of this rapid growth, understanding the processes of successful online teaching and learning are increasingly important for modern institutions.

There are different types of online courses, ranging from courses with some online content to fully online courses (Allen & Seaman, 2005). In fully online settings, experienced instructors generally find that some form of learning community approach works best (Palloff & Pratt, 2001).

Learning Community Approaches

The three principal learning community approaches are *communities of practice* (CoP) (Brown & Duguid, 1991); *activity theory* (AT) (Cole & Engeström, 1993); and *knowledge building* (KB) (Scardamalia & Bereiter, 2003). These approaches all have sufficiently strong similarities that some consider they are the same (Botkin, 2003). This study worked with a class using the knowledge building approach. In knowledge building communities, students model the behaviours of scientific research communities. They research real-world problems using their own ideas as the starting point, and use an asynchronous discourse environment to elaborate on and synthesize ideas (Bereiter & Scardamalia, 1993; Scardamalia, 2003; Scardamalia & Bereiter, 1992; Zhang *et al.*, 2004).

It is important to note that the learning community approach is not limited to schools. Current business theorists often speak of learning community or knowledge community approaches as the way forward in business environments, usually in conjunction with the concept of a *learning organization* (or *knowledge enterprise*) (Bennet, 2003). Chatzkel (2003, p. 397) notes, "There is no split between learning and working the next-generation knowledge enterprise", and Bennet (2003, p. 369) further notes that knowledge enterprises need a mediating tool, such as a computer, to facilitate this. Smith (1994) and Lévy (1997; 1998) refer to these work processes as *collective intelligence*. Others (e.g. Johnson (2001) and Gloor (2006) refer to these as *swarm* processes.

One thing that is clear in any discussion of collaborative work, either in schools or in business, is that we have little understanding of the dynamics of group processes and what characterizes adaptive versus maladaptive group dynamics. One approach that has begun to be used is an innovative *network science* approach to the understanding of communication patterns among group members (Palonen & Hakkarainen, 2000; Sha & van Aalst, 2004; Philip, 2004). Such analyses are made possible by the advent of online tools to track student interactions in online learning environments, and computer software to analyze network interactions.

Network Theory

The formal study of networks began in 1736 when the mathematician Euler realized that certain classes of problem could be analyzed graphically, that is, by drawing a diagram consisting of *nodes* and connecting *arcs* or *edges* (Watts, 2003), creating a kind of network. Known as *graph theory* in mathematics, the study of networks of various kinds has spread to a number of disciplines such as chemistry (crystal lattice structure); physics (power grids); ecology (food webs in ecosystems); biochemistry (chemical interaction networks within cells); sociology (social network analysis); and many more (see Buchanan, 2002, for a readable introduction to this area.) Common to all of these approaches to networks is the visualization of the network as a diagram of nodes and edges, and the associated mathematics that has developed around this.

The current interest in networks in studying group dynamics arises from the study of Chaos/Complexity theory (Gleick, 1987; Kauffman, 1995), in which systems which had previously been thought to show random dynamics in fact show hidden order. The search for the causative factors in these systems has led to an increasing interest in the networks of interactions among members of the systems, resulting the creation of a new type of science – *network science* (Barabási, 2002; Buchanan, 2002; Watts, 2003). Mathematical analyses of networks, such as e-mail communication networks in businesses (Gloor, 2006), show distinct patterns that can be identified and classified, allowing us to identify adaptive and maladaptive behaviours among groups and members.

Methodology

The preceding analysis indicates that in order to understand and assess learning communities, it is necessary to understand the group processes operating within the group; and network science provides tools to enable us to analyze the group processes among community members. What this means in practice is that if we can extract the details of communication among members of online learning communities, we can analyze these using network analysis techniques and determine any patterns of interaction that might appear. These patterns of interaction will tell us about communication among group members, about collaboration among group members, and about who is taking the lead in the group at any one time.

A unique feature of the *Knowledge Forum* (KF) online learning environment is that it includes a suite of analytic tools called the *Analytic Toolkit* (ATK) written by Jud Burtis. The ATK allows instructors to track the interactions between students and the online environment, and can provide the matrices needed to do network analyses on the interactions and data on the usage patterns of various of the network-related features provided by Knowledge Forum.

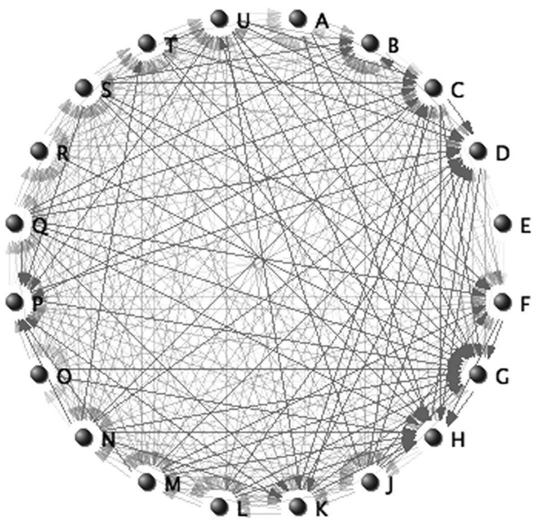
The current study examined the communication patterns among a group of students using KF as an adjunct to their classroom work, using the ATK data to examine the online interactions. Three of these are reported on here: (1) *Who has read whose notes* (student reading behaviours); (2) *Who has built onto whose notes* (student writing and commenting behaviour); and (3) *new note contribution* (initiating threads of ideas for discussion.) Note reading, and building-on are collaborative communication behaviours; new note contribution is a communication behaviour necessary to initiate new discourse. All three of these behaviours are common to all online learning environments.

The Class

The class participating in this study was a combined Gr. 5/6 class of 20 participating students in a school in a large Canadian city. Located in the downtown core of the city, the school is multi-ethnic and co-educational, as is typical of the schools in Canadian cities. Many of the students do not speak English as their first language, and a number are immigrants. All were experienced in the use of the KF online environment at the time of the study.

The class proceeded in a hybrid fashion: there were live class sessions, and online discussions. The students do not particularly distinguish between these, as they are accustomed to both. In practice, the teacher posed a problem of understanding to the students and they proceeded to research and discuss the material both online and offline. The teacher dedicated large blocks of classroom time to online discourse so that the students could make effective use of the online environment, and the classroom was well provided with computers for this purpose.

Figure 1. Traditional circular sociogram showing a very high note reading density.

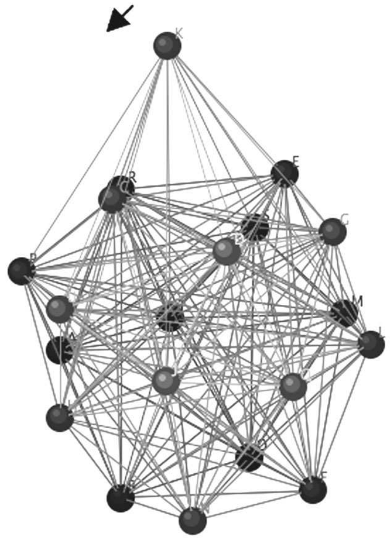


For this study, one particular online conference was studied, and the ATK results extracted were for this conference only during a six-week time period during which they were studying a history unit dealing with ancient civilizations.

Results

Figure 1 shows a traditional circular sociogram of the *note reading* behaviour for this class ("Who has read whose notes".) Analysis of it reveals that the students had read on average 92% of each other's notes – a remarkably high percentage. Figure 2 is of the same data, but shows a less traditional, three-dimensional representation using a *spring algorithm*. The spring algorithm assigns a set of attractions and repulsions among students based on the number of notes by each other student that they have read, and this is rendered as a 3-D sociogram, It shows that some

Figure 2. Three-dimensional representation of note reading created using a spring algorithm. Note that student K (indicated by an arrow) is not as closely connected to the central mass of the group as the other students are.



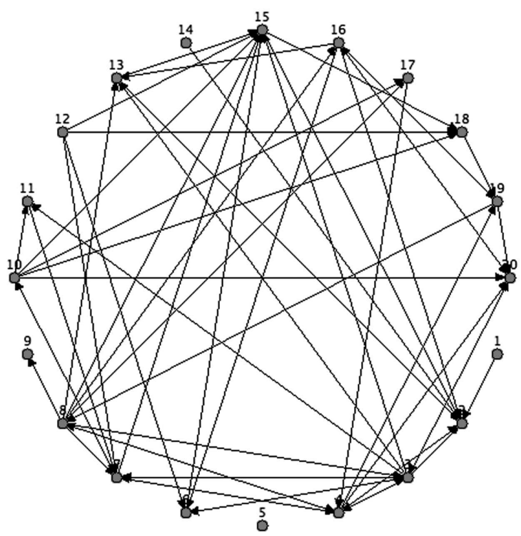
students are not as closely connected to the group as others, as can be clearly seen with student K (at the top.)

In this case, these data show that the class is functioning very well as a collaborative knowledge-building group. Extensive reading of other student's notes means that communication among group members is good, and that the ideas expressed by other students are being effectively communicated among class members.

Contrast Figures 1 and 2 with Figures 3 and 4. Figures 3 and 4 both show *building-on* behaviour. Figure 3 shows all of the build-ons among this group of students. While the density of building-on isn't particularly high (15%,) it appears the students are quite regularly building onto other students' notes. However, things are not quite as they seem. Figure 4 shows the same data, but in this case, shows only the students who have *frequently* built-on to other students' notes.

Therefore, not only is building-on relatively rare in this class, but it is evident that relatively few students build on regularly. However, it's not all bad news. In Figure 4, the cluster of students B, C, D, and G are shown

Figure 3. Build-on data from the class. This is unfiltered, and shows all events.

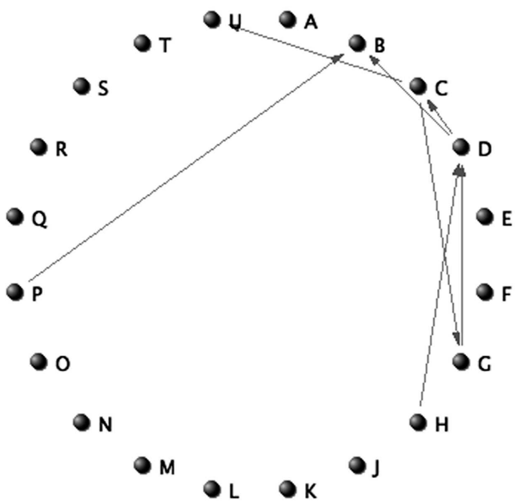


quite clearly to be the class leaders in building on, and Figure 3 shows that aside from student S, most students have either built onto other's notes, or had their notes built onto. The class knows how to use build-ons, but simply isn't doing enough of it. An instructor provided with this type of information could decide that for building-on, the group process is not working as effectively as it should and intervene to ensure that students are aware that they should be building on more often.

Figure 5 shows a different type of data – the number of notes created by each student during the study period. Networks, of course, have to start somewhere, and new notes are where networks of ideas start, so it is important to look at this.

To create Figure 5, the data have been sorted highest to lowest and graphed. As can be seen, the pattern of note contribution for the class shows a high curve fit to linear (R-squared closeness-of-fit = 88%) and has a relatively gently slope of 0.65. The gentleness of the slope indicates that there is considerable evenness of participation among the students in note creation. There is an obvious gap between the top four students and the rest, again indicating that some students are taking leadership roles in note

Figure 4. The same build-on data as Figure 5, but filtered. This shows only those students who frequently build onto others students' notes.



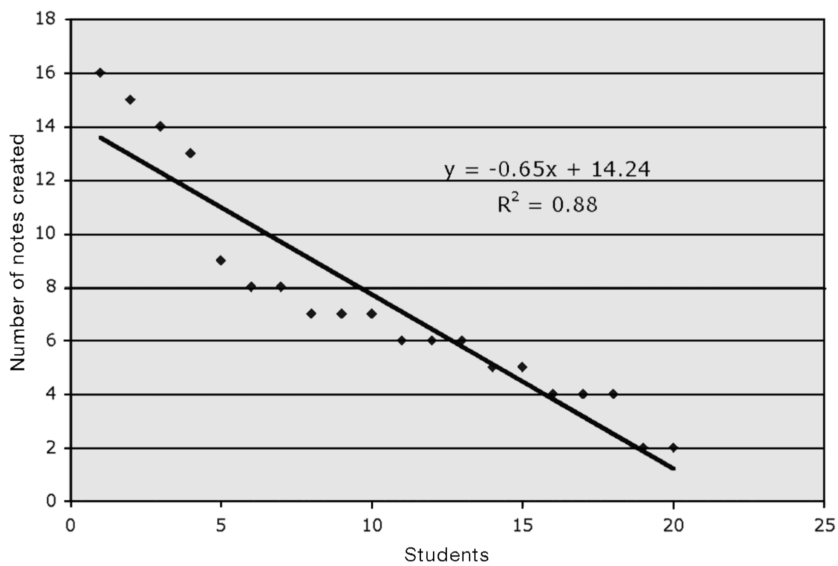
creation. As well, some students at the lower end of the group obviously need to initiate more discussions. However, in a hybrid class, it is possible that these students actually did contribute to new note contribution by co-authoring informally with other students. These measures cannot be applied blindly to a group, but can only be properly interpreted with the help of the instructor who knows what is actually going on in the class.

Conclusions

As online learning becomes increasingly common at all levels of education, it becomes critical to learn how to understand the group processes that enable these groups to function properly. Because online interactions can be tracked, it is possible to examine group processes from a network perspective, using the techniques of network analysis, and to apply these analyses to the class.

Using network analysis techniques, it was shown that the Gr. 5/6 class under study had a remarkably high note reading density with the

Figure 5. New note creation by the students during the study period.



students having read 92% of each others' notes. The network analysis also showed a student who was atypical, indicating a possible need for an intervention by the instructor.

The build-on pattern for the class revealed a leadership cluster of students who were doing most of the building-on, but also revealed that most students were participating in building-on at least some of the time. One student did not participate in building-on, indicating a possible need for an intervention.

New note creation revealed a linear curve fit with a slope that was not particularly steep – an indication of evenness of participation among class members. Again, it was possible to see a cluster at the upper range of note contribution, and that some students at the lower end might need to be encouraged to contribute more in this area.

One *caveat* that has to be mentioned is that although these data can be harvested and analyzed automatically, it is not possible to interpret the results in any meaningful way without input from the instructor. Students can be ill; students can be on vacation with their parents; students can be working informally with other students; and so forth. Interpreting the results without input from the instructor is likely to result in errors.

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