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Exploring Classroom Community: A Social Network Study of Reacting to the Past

ABSTRACT

In this exploratory social network study, we examined how student relationships evolved during three month-long Reacting to the Past (RTTP) role-playing games in a lower division honors course at a large US public university. Our purpose was to explore how RTTP games—and collaborative learning approaches more generally—impact classroom community in college courses. We found that both acquaintance and friendship ties between students increased dramatically during the game, eliminating student isolation without tending to create new cliques. These added ties made acquaintance and friendship networks simultaneously denser and more inclusive than they were before the game. We conclude by advancing a hypothesis about the network effects of intensive peer interaction. Collaborative learning approaches like RTTP, we suggest, produce high-density networks with limited clustering because structured peer interactions cut across existing or naturally occurring clique boundaries.

KEYWORDS

classroom community, social networks, role-playing games, higher education, collaborative learning

Developed at Barnard College (New York, US) and now used at over 300 colleges and universities throughout the world, Reacting to the Past (RTTP) is a teaching method consisting of role-playing games, often lasting multiple weeks, in which students explore historical situations in the first person. These games are incorporated into classes in history, political science, art, physics, literature, philosophy, and other disciplines. Assuming roles based on historical figures from competing ideological "factions," students re-enact past events by using speeches, written arguments, and networking to influence their peers in rival factions. They work intensively with one another both within and across their assigned factions. Multiple observers have noted that the method inspires high levels of student interactivity and builds classroom community (Carnes, 2011; Carnes, 2014; Burney, Powers, & Carnes, 2010).

We can't overestimate the importance of classroom community for learning. As Astin (1993) argued over two decades ago, "the student's peer group is the single most potent source of influence on growth and development during the undergraduate years" (p. 398). Subsequent studies on learning community participation have underscored this point (Pike, Kuh, & McCormick, 2010; Tinto, 1997; Zhao & Kuh, 2004). Furthermore, scholarship on non-cognitive predictors of academic performance has shown that students who feel part of an intellectual community, who feel a sense of belonging, are better motivated, more engaged, resilient and persistent, and get better grades (Farrington et al., 2012; Farrington, 2013; McKinney, McKinney, Franiuk, & Schweitzer, 2006; Osterman, 2000). Yet the nature of community in college classrooms

remains understudied and poorly understood. We know that classroom community matters in college, but we do not know much about its formation or structure. In the case of RTTP's purported effect on community, for example, we can ask the following: What sorts of student relationships form during a game? How do they change the existing social structure in the class? Does the fact that students work in factions lead to the formation of cliques?

These questions oriented the study we describe here. We examined how student relationships evolved during three month-long RTTP games played in the spring semester of a lower division honors course at a large US public university. Given the limited research on community formation in RTTP classes, our purpose was exploratory: to develop a hypothesis about how teaching approaches emphasizing peer interaction, such as RTTP role-playing games specifically and collaborative learning more generally, impact classroom social structure, a hypothesis potentially informing further inquiry. Our purpose was therefore neither to assess RTTP as an instructional technique in this one class, nor to investigate its impact on learning, but instead to develop a broad hypothesis about the network effects of intensive, structured peer interaction.

REACTING TO THE PAST

In the 1990s, Carnes (2011), observing disengaged students in his classes, envisioned a teaching approach that would incorporate elements always present on college campuses but not usually found in the curriculum: subversive play worlds. He introduced three RTTP games, one on Athens in 403 BCE, another on the Chinese succession at the end of the Ming Dynasty, and a third on the trial of Anne Hutchinson. Each game consisted of ten sessions: three sessions in which the professor introduced the time period, texts, and issues to the students; six sessions in which students took over the class with their debates over a series of topics; and a final session in which the instructor explained what happened historically and allowed students to reveal their roles and strategies within the game.

During the games students represent important ideological viewpoints in a controversy. In order to be successful, students must not only interact with the professor to demonstrate mastery of concept and abilities but also strategize and work intensively with each other—both within and beyond their own groups. Thus, the games require more of students than just sitting in a classroom, and the professor becomes more of a coach and consultant than lecturer. RTTP requires students to engage firstly with evidence in the form of primary texts and documents, includes consciousness of inference and judgment, and promotes the presentation and collision of multiple viewpoints. Interacting with each other in their roles, students demonstrate that "there is not one true story about the past, but a multiplicity of complementary, competing, or clashing stories" (Lee, 2004, p. 129). In his recent book *Minds on Fire*, Carnes (2014) describes how in one playing of the Anne Hutchinson trial game a student of immigrant background "reshaped" historical texts to fit his "alternative narrative of immigrant survival in a hostile world," while other students in the class simultaneously refuted his interpretation (p. 255). Students experienced the elusiveness and contested nature of history.

From those early beginnings, RTTP has expanded exponentially. There are now 10 published games, over 20 reviewed and play-tested games, and over 50 other games in some stage of development. Shorter games and games for a STEM curriculum have also been introduced. Instructors can choose to have entire courses based around games or incorporate one or two games into a more traditional instructional context.

CLASSROOM COMMUNITY AND UNDERGRADUATE EDUCATION

Community belonging is essential to human well-being, motivation, and learning (Dewey, 1938; Maslow, 1943; Vygotsky, 1958). At this point, a large body of evidence from a number of theoretical directions has converged to establish the associational—and in some cases causal—link between psychological sense of belonging and various dimensions of academic performance, including motivation, engagement, resiliency, persistence, and grade achievement (Deci, Vallerand, Pelletier, & Ryan, 1991; Farrington et al., 2012; Farrington, 2013; Good, Aronson & Inzlicht, 2003; Good, Rattan, & Dweck, 2012; McKinney et al., 2006; Osterman, 2000; Summers & Svinicki, 2007; Walton & Cohen, 2007, 2011; Yeager & Walton, 2011). Research on first-year learning communities in college lends support to these conclusions. While Osterman (2000) emphasizes that "belongingness is a subjective phenomenon" (p. 344), participation in a learning community has been associated, directly and indirectly, with improved student performance (Pike et al., 2010; Tinto, 1997; Zhao & Kuh, 2004). In an influential article, "Classrooms as Communities," Tinto (1997) identifies the classroom dynamics of learning communities that lead to improved performance: these relationships offer students both support and challenge. Students are supported as their friendships help them bridge the "academic-social divide," affording membership in "the broader social communities of the college while also engaging them more fully in the academic life of the institution" (p. 613). Students are also challenged in learning communities through collaborative and discussion-oriented pedagogies, which expose them to a diversity of perspectives, enriching their intellectual experience. For Tinto, these two important outcomes—support and challenge—crucially depend on the "small supportive community of peers" that develops in the classroom (p. 609).

As a concept and an empirical phenomenon, however, classroom community remains unelaborated in this work. The same generality tends to appear in other research on learning communities. For example, in a large-scale study using data from the National Survey of Student Engagement (NSSE), Zhao and Kuh (2004) attribute the success of learning communities partly "to the linking of students through ongoing social interactions afforded by being with the same students for an extended period of time" (p. 117). But these authors do not characterize the community resulting from these interactions so much as they assert it: students are linked. Yet how are they linked? Do social interactions in these classes produce friends or acquaintances? How quickly do the associations form, and how long do they last? Do they create cliques? In short, what sorts of communities tend to develop in these classrooms? The research literature on college learning communities is largely silent on these questions. Not surprisingly, community structure also remains unexplored in the literature on belongingness, given the psychological rather than sociological focus of this work. The sense of belonging approach thus has limited value for understanding the social structure underlying students' perceptions of community or ways to intervene if there are problems with that structure.

And there can be problems. These tend to get glossed over in the foundational literature on learning communities where the classroom social environment is idealized as a supportive community. Jaffee (2007) argues that the desired outcome in learning communities—the formation of a cohesive peer cohort—can have negative unintended consequences, such as the formation of cliques. Citing Cooley's (1962) work on secondary and primary groups, Jaffee distinguishes between the "personal, intimate, and enduring socioemotional bonds" of primary groups that develop in learning community classrooms and the less personal secondary groups that develop in more traditional classrooms, where students tend to be disconnected from one

another (p. 67). The relationships among students in learning communities typically extend beyond the classroom. These are precisely the sorts of relationships extolled by Tinto (1997) as offering students support by bridging the academic-social divide, but they can result in classroom dynamics that jeopardize the other key learning community outcome he identifies: challenge. Primary group relationships are, Jaffee argues, more likely to produce classroom cliques that engage in "groupthink," enforcing social conformity among members and stifling the expression of diverse perspectives (p. 68). In other words, students are not challenged by close friends to think critically. Consequently, classrooms dominated by cliques with little interaction across group boundaries may lack the diverse voices that for Tinto enrich the intellectual experience of college.

Jaffee (2007) acknowledges, however, that the emergence of exclusive cliques is dependent on teaching approach and can be controlled with collaborative and cooperative methods. According to Bruffee (1993), an early proponent of collaborative learning, the use of temporary "consensus groups" in the classroom "can threaten clique values and, by cutting across clique loyalties, weaken them" (p. 33):

> *Change in group membership helps students enlarge their acquaintance, escape aversions and entrenched enmities, dissolve entrapment in cliques, and acquire new interests and abilities by working with a variety of student peers.... [T]he teacher's goal is to create a collaborative class as a whole, not an aggregate of loosely federated mini-classes coherent in themselves but unrelated to all the others. (p. 35)*

Collaborative work, in other words, encourages the formation of secondary groups alongside primary groups, enlarging what we might describe as students' social capital: nudged out of their cliques, they encounter diverse peers and new perspectives. According to recent research, in fact, students who regularly interact with diverse peers show comparatively greater intellectual development, particularly in cognitive domains such as critical thinking (Bowman, 2010; Curseu & Pluut, 2013; Pascarella & Terenzini, 2005; Pascarella & Blaich, 2013). Where Bruffee describes temporary consensus groups managed by the teacher, students playing RTTP take complete responsibility for class time over multiple weeks and their open-ended interactions, based on their study of assigned texts, constitute the core of the learning experience.

SOCIAL CAPITAL THEORY

Social capital theory provides the theoretical perspective for the research we describe here. Network theorists distinguish between bonding and bridging forms of social capital (Burt, 2005; Putnam, 2000). For Burt (2005), people in tight-knit peer groups exhibit high levels of trust but tend to share redundant information; they know the same things, as "Opinions and behaviors within a group are often expressed in a local language, a dialect fraught with taken-for-granted assumptions shared within a group" (p. 17). He therefore emphasizes the social capital benefits of bridging between groups; such brokerage provides "access to diverse information, beliefs and behavior" (p. 90). Granovetter (1983) makes a similar point by distinguishing between the network functions of close friends and those of acquaintances. New information travels most readily through weak network ties in conversations between acquaintances. His example is getting a job. People with "few weak ties will be deprived of information from distant parts of the social system and will be confined to the provincial news and views of their close

friends. This deprivation will ... insulate them from the latest ideas and fashions" (p. 202).

These accounts of social capital allow us to elaborate Bruffee's (1993) account of effective collaboration, which he describes as having a particular network structure: students may feel a sense of belonging in such a class, but the crucial fact about the classroom community is that it consists of not only cliques of friends supporting each other but also acquaintances bridging between cliques. This sort of brokerage disrupts groupthink, exposing students to ideas that challenge the assumptions shared in a group. This combination of bonding and bridging social capital is, we propose, an important structural result of collaborative learning approaches like RTTP—important because the learning outcomes associated with classroom community depend on both peer support and challenge (Tinto, 1997).

CLASSROOM NETWORK FORMATION

How do lower-division college students form relationships in a relatively small class of 20 or 25? Imagine such a class taught through lecture. In this case we would expect fairly low levels of peer interaction not only because opportunities are few with student involvement restricted to questions directed occasionally at the professor, but also because the lecture format implies that peer involvement is irrelevant to the central purpose of the course. The fact that students sit together in the classroom is a convenience of scale; the professor is really communicating with individual minds. Bruffee (1993) writes,

> *Traditional teaching places teachers at the center of attention. Conversation goes on between the teacher and each individual student in the room. Traditional lecturers seem to be speaking to a socially coherent group of people. Actually they are speaking one to one, to an aggregate set of isolated individuals among whom there are no necessary social relations at all.* (p. 31)

How would relationships form in such a class? They may not. Students in traditional classes tend to be disconnected (Jaffee, 2007). If student relationships do form, however, they might start with existing ties. For example, some students, already acquainted, may choose to sit near each other and talk before class. A student with two unacquainted friends might introduce them, thus forming a triangle. Other students with no existing ties might be motivated to make acquaintances—again, with those sitting nearby—in order to acquire study partners or to form study groups. Nevertheless, the opportunity for new contacts in such classroom environments is extremely limited since students infrequently change seats. In discussing the physical environment of groups, Shaw (1971) notes that students assume territorial rights over particular chairs. This territoriality—to the extent it is respected by others—tends to produce relatively unchanging seating arrangements. From this perspective, the social structural signature of lecture-style teaching would be small, unconnected cliques with many isolated students.

These cliques would also likely be homogeneous. Social network research has identified two main mechanisms governing tie formation: propinquity and homophily (Christakis & Fowler, 2008; McPherson & Smith-Lovin, 2001). People tend to form relationships when they are in close proximity (propinquity) and when they have similar characteristics (homophily). In the case of the hypothetical lecture class above, what looks like tie formation governed by propinquity—students sitting near each other become acquainted—may actually be a process driven by homophily—students who are already acquainted and probably similar choose to sit

near each other. Social network studies have found strong tendencies towards social segregation among high school students by grade, gender, and ethnicity or race (Goodreau, Kitts, & Morris, 2009). Jaffee (2007) attributes the prevalence of cliques among first-year students to the "mutually reinforcing high school-like environment" that can develop in these classrooms (p. 67).

In contrast to teaching approaches that may reinforce existing social relationships among students, collaborative learning intervenes in classroom social structure, making tie formation more a function of propinquity than of homophily. For Bruffee (1993), random assignments to temporary small groups ensure that students are regularly exposed to peers beyond their immediate cliques. Students in collaborative learning classrooms likely develop more social capital than students in traditional classrooms. Their networks include more brokerage and hence provide better access to diverse perspectives. They are in a better network location for learning. The value of brokerage is thus partly epistemological. If friends know the same sorts of things, then bridging between friendship cliques through connections with diverse acquaintances exposes students to new, enlarging perspectives. Thus, friends are important, but—and this is a point that has been too little emphasized in the student development literature—*so are acquaintances*.

RESEARCH QUESTIONS

Our review of the literature prompted the following two sets of research questions. First, we wanted to explore ties: *Did network ties increase during the RTTP games played in this class?* This question needs to be posed in terms of both acquaintance and friendship ties: *Did acquaintance ties increase during the games? Did friendship ties increase? Were there, moreover, differences in the number of acquaintance and friendship ties added during the games?* Next, we wanted to study cliques: *Did the ties added during the RTTP games reinforce or diminish the exclusivity of existing cliques? That is, if groups of students entered the class already knowing each other, did their new relationships tend to be confined to their existing cliques? Did this pattern differ for acquaintance and friendship networks? And, given that students work in factions, were the ties added during the games exclusive with respect to faction membership?*

Our aim in asking these questions was to find out whether network evolution in this class supported the anecdotal reports of strong classroom communities—dense networks that are relatively free of cliques—forming during RTTP games.

DATA AND METHODS
Class description

This study explored social network changes during three RTTP games played in a lower-division spring semester honors class at a large public university in the United States. The second author of this paper taught the class. This particular class enrolled 24 students, the majority of whom were first- and second-year students. Nine were male and 15 female. Some students were acquainted with each other before taking this class. Ten students had been in the professor's class the previous semester and belonged to the Early Assurance (EA) cohort program, in which most students take two classes together fall and spring semesters of their first year at the university. Two other students were EA students but had not been in the previous semester's class. Two students had taken other RTTP classes from the professor but had not been in the same class.

Course procedures and curriculum

Students played three games over the course of the semester: *The Trial of Galileo: Aristotelianism, the "New Cosmology," and the Catholic Church, 1616-33* (Purnell, Pettersen, & Carnes, 2014); *Rousseau, Burke, and Revolution in France, 1791* (Kates & Carnes, 2014); and *Charles Darwin, the Copley Medal, and the Rise of Naturalism, 1862-1864* (Driscoll, Dunn, Siems, & Swanson, 2014). Each game followed the standard template for RTTP games: two to three days of instruction with a quiz over the reading material, six to seven days of student-led debate, and one day of analysis of historical events and the game.

Data collection

Four identical network surveys were administered online in this class: one early in the semester on January 8, and the second on February 17 after the completion of the first game. The third and fourth surveys were administered after the second and third games on March 31 and April 16 respectively. The surveys took approximately three to four minutes to complete. They consisted in two network questions referencing the class roster:

1. "Which of your classmates do you consider friends? For the purposes of this survey, a friend is someone you know fairly well, with whom you would spend time outside of school."
2. "Which of your classmates do you consider acquaintances? For the purposes of this survey, an acquaintance is someone you know, but perhaps not very well. If you saw this person on campus you would probably say hello and might stop and talk."

Students reached the surveys by following a link in an email invitation. If a student had not completed the survey within a day of the email invitation, a follow-up email was sent, which also included a link to the survey. In all cases, the survey was closed before the next RTTP game began.

The acquaintance and friendship relationship categories in the survey were meant to be mutually exclusive, but a modest number of students selected classmates as both friends and acquaintances on some of the surveys. In these cases, the friend nomination was given priority as the more familiar and therefore probably more accurate relationship designation; the friend was then removed from that student's list of acquaintances.

Due to late enrollment, one student was left off the survey roster and was unable to take any of the surveys or to be selected by other students. The class represented in the networks considered here therefore numbered 23 students. Response rates to both surveys were good. All students on the roster completed the first and second surveys; two students did not take the third and fourth surveys. While missing observations pose challenges for network analysis, particularly for directed networks, we conducted simulation studies suggesting that these response rates were adequate for our analysis—a conclusion supported by published research (Costenbader, 2003).

Data analysis

Given the theoretical orientation discussed above, we operationalized classroom community as social network in this study and used exponential-family random graph models, or ERGMs, to explore the evolution of community structure. Because network observations are dependent, conventional statistical techniques like linear regression will, when used with network data, tend to underestimate standard errors and inappropriately return significant p-values (Lusher, Koskinen, & Robins, 2013). By contrast, ERGMs model these dependencies

directly (Lusher et al., 2013; Hunter & Handcock, 2008). Using this modeling approach allowed us to make statistical inferences about the propensity of students in this class to form ties, and to form exclusive ties, or cliques, based on EA membership and RTTP faction (Lusher et al., 2013).[1] See Table 1 for a brief summary of the network terms and concepts used in the article.

Table 1. Summary of network terms and concepts

CONCEPT	SUMMARY
Nodes or vertices	The circles representing students in the networks pictured in Figures 1 and 2.
Edges or ties	The lines between nodes in Figures 1 and 2 representing relationships between students. Directed ties preserve the directionality of friend or acquaintance nomination. In graphs of directed networks, edges have arrows to indicate the directionality of the relationship.
Triangles or closed triads	Three interconnected nodes. In a directed network there are 16 possible triadic configurations (Davis & Leinhardt, 1974). The number of triangles in a network measures local cliquishness or clustering (Kadushin, 2012; Valente, 2010; Wasserman & Faust, 1994).
Density	A network-level measure of connectedness consisting in the number of observed ties divided by the number of possible ties (reported here as a decimal between 0 and 1) (Kadushin, 2012; Valente, 2010; Wasserman & Faust, 1994). The more connections in a network, the higher the density.
Degree	The number of ties for a given node, which, in a directed network, includes both outgoing ties (outdegree) and incoming ties (indegree)—the number of times a given node has nominated or been nominated by others. Each node has a degree. The degree distribution is a list of the degrees for each node in a network (e.g., 5, 2, 0, 3, ...).
GWESP	Geometrically Weighted Edgewise Shared Partner Distribution: "an alternative approach to counting triangles. Two actors 'share' a partner if both have a tie to the same partner, and each shared partner forms a triangle if the original pair are tied" (Goodreau et al., 2009). In this study, we used GWESP to count the number of triangles in the network.

Did network ties increase during the three RTTP games?

As suggested by increasing network densities through the semester (Figures 1 and 2), ties were added to each network, contributing to a large overall increase in ties during the semester (Table 2 and Figure 3).[2]
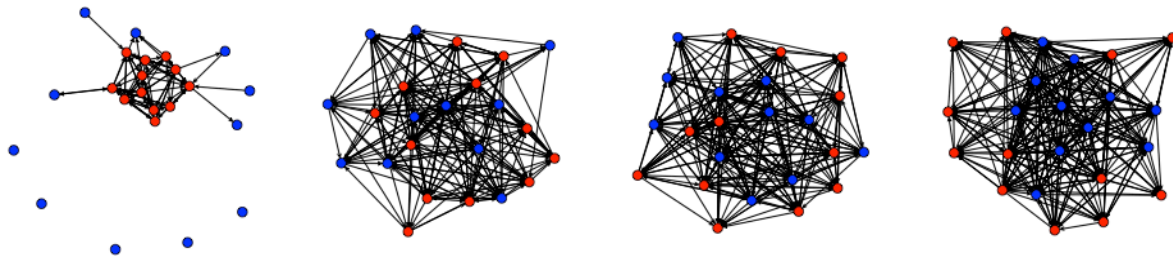
Figure 1. The acquaintance network before the first RTTP game (left), after the first game (left center), after the second game (center right), and after third game (right). These networks represent the results, at different points in time, of the second network survey question referencing the class roster: "Which of your classmates do you consider acquaintances? For the purposes of this survey, an acquaintance is someone you know, but perhaps not very well. If you saw this person on campus you would probably say hello and might stop and talk." The nodes in these graphs are colored by EA participation (red). The densities of these networks, from left to right, were .17, .5, .57, .67.
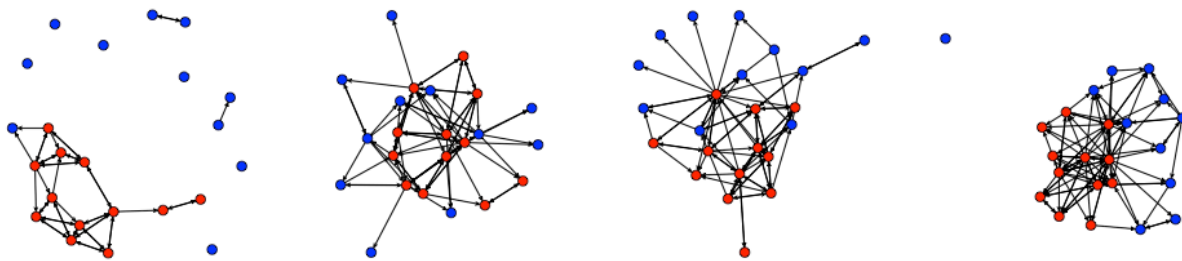

Figure 2. The friendship network before the first RTTP game (left), after the first game (left center), after the second game (center right), and after third game (right). These networks represent the results, at different points in time, of the first network survey question referencing the class roster: "Which of your classmates do you consider friends? For the purposes of this survey, a friend is someone you know fairly well, with whom you would spend time outside of school." The nodes in these graphs are colored by EA participation (red). The densities of these networks, from left to right, were .1, .16, .16, .2.

Table 2. Network ties added during RTTP games

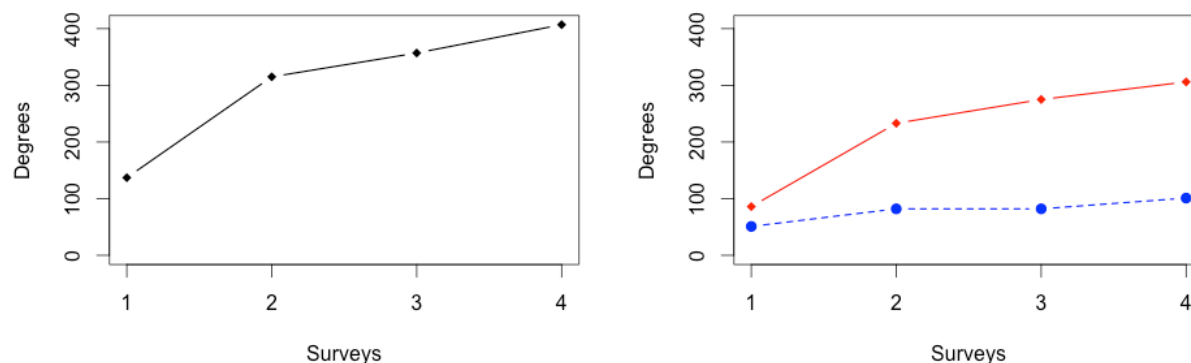| Time	Acquaintance ties added (net)	Friendship ties added (net)
First game	147	31
Second game	42	0
Third game	31	19
Total	220	50

Figure 3. Total increase in ties during the semester (left) compared to the increase by relationship type (right): acquaintance ties (red) and friendship ties (blue). The x-axis represents surveys administered at the very beginning of class (1), and thereafter at the conclusion of each RTTP game (2-4). The increase in ties at these latter times corresponds to the numbers in Table 2.

Comparing network degree distributions statistically showed that the amount of acquaintance ties increased differed significantly from the amount friendship ties increased during each game with the biggest difference occurring during the first game (corresponding to survey two in Figure 3). Indeed, while the increase in friendship ties was modest or nonexistent (31, 0, 19), the increase in acquaintance ties was quite large during the first game (147) but decreased fairly rapidly during the second and third games (42, 31).[3] The cumulative increase in acquaintance ties over the course of the three games (220) was, of course, much larger than the increase in friendship ties (50). Notably, after the first game, all students had developed multiple acquaintance ties and at least one friendship tie. Sometimes student relationships ended, as when a formerly connected student reported no friendship ties after the third game.

Did the ties added during RTTP games reinforce or diminish the exclusivity of existing cliques?

To assess changes in classroom cliques, we fit an ERGM to the cross-sectional acquaintance and friendship networks before the first RTTP game. The model included as predictors variables representing edges and triangles (operationalized as GWESP) as well as variables representing the propensity for Early Assurance (EA) cohort students to form ties in general and ties with each other in particular. These variables are titled "EA ties" and "EA homophily," respectively, in Tables 3 and 4. RTTP faction was obviously not a relevant consideration for this model since the first game had not yet begun. In subsequent models we included variables representing the propensity for students in factions to form ties in general and ties with each other in particular. These are titled "Faction ties" and "Faction homophily," respectively, in Tables 3 and 4.[4]

Table 3. ERGMs for Acquaintance Networks

	Before game 1	During game 1	During game 2	During game 3
Edges	−6.44***	−0.61	−0.03	3.02
	(0.63)	(1.21)	(9.08)	(2.45)
GWESP	−0.60***	0.20	0.27	−0.78
	(0.07)	(0.58)	(4.42)	(1.14)
EA ties	3.55***	−0.68***	−0.47	−1.60***
	(0.53)	(0.19)	(0.25)	(0.31)
EA homophily	1.75**	−0.27	0.02	−0.15
	(0.63)	(0.23)	(0.26)	(0.33)
Faction ties		0.29	−0.08	.22
		(0.24)	(0.32)	(0.35)
Faction homophily		0.58**	0.41	−0.43
		(0.25)	(0.35)	(0.35)
***$p < 0.001$ **$p < 0.01$ *$p < 0.05$; (SE)				

Table 4. ERGMs for Friendship Networks

	Before game 1	During game 1	During game 2	During game 3
Edges	−5.43*** (0.67)	−4.32*** (0.72)	−5.22*** (0.96)	−4.37*** (0.51)
GWESP	1.48***	0.33	0.14	0.94***
	(0.43)	(0.25)	(0.27)	(0.21)
EA ties	0.28	0.35	0.29	−0.04
	(0.36)	(0.31)	(0.37)	(0.24)
EA homophily	1.78**	0.26	0.62	−0.60
	(0.68)	(0.34)	(0.43)	(0.35)
Faction ties		0.46	0.76	−0.39
		(0.38)	(0.62)	(0.33)
Faction homophily		0.94**	0.18	0.53
		(0.35)	(0.49)	(0.38)
***$p < 0.001$ **$p < 0.01$ *$p < 0.05$; (SE)				

Given that Figures 1 and 2 showed EA students clustered together in the networks before the first RTTP game, our aim in fitting the first ERGM was to establish baseline measures of two variables described above for later comparison with the three dynamic networks of ties added during the games: EA homophily and GWESP. Tables 3 and 4 summarize this and subsequent models.[5]

In both pre-game networks, EA students showed a propensity to form exclusive ties with each other: the coefficient for the EA homophily variable was positive and significant. Specifically, EA students in the acquaintance network were about two times more likely than non-EA students to form exclusive triads, while those in the friendship network about twenty-five times more likely to form exclusive triads.[6] The propensity for all students to form exclusive ties differed between the pre-game networks: the coefficient for the GWESP variable was significant in both networks but in different directions—negative in the acquaintance network but positive in the friendship network. Specifically, students in the acquaintance network were about half as likely to add a tie that would complete a triangle than they were to add a tie that did not complete a triangle, whereas in the friendship network they were 3.4 times more likely to add such a tie.

Were the ties added during the RTTP games similarly exclusive?

We fit models using the same variables described above, plus faction variables, to the three dynamic acquaintance and friend networks from the semester—the networks defined by ties added and subtracted during each of the three games. The addition of the faction variables allowed us to test whether faction was associated with tie formation and, most importantly for our purposes, whether it was associated with the exclusivity of tie formation.

In the acquaintance networks, the coefficients for neither GWESP nor EA homophily were significant during any of the three games. Ties added to these networks, in other words, did not display any tendency to close triangles and did not occur with comparatively higher frequency among EA students. The same basic pattern was observed in the dynamic friendship networks, with one exception: GWESP was significant for the third network, corresponding to ties added during the final game.

To assess whether there was exclusivity among students working together in RTTP factions, we entered the faction homophily variable into each model and determined its significance by comparing models using the Likelihood Ratio Test. We used this approach because we were interested not in differences between factions with respect to the reference case but in whether the factions considered together as a block explained the structure of the network. This required comparing models with and without this variable. (Since in this case the log likelihood was the metric of interest, coefficients and standard errors for faction ties and faction homophily were averaged in Tables 3 and 4, and the significance reported there is for the likelihood ratio test comparing models.)

During the first game, ties among students in factions in both networks showed a propensity for exclusivity. Students were on average about 80 percent more likely to form acquaintance ties with those in their factions and about 1.5 times more likely to form friendships than they were to form ties that were non-homophilous with respect to faction. There was, however, no such tendency in the second or third games. Moreover, the non-significant GWESP variable indicates that there was no additional tendency during any of the games for these added within-faction ties to complete triangles.

DISCUSSION

In this exploratory social network study, we examined the evolution of student relationships during three RTTP role-playing games in a lower-division honors class at a large US public university. Our objective was to describe the network changes that took place during the games, with the aim, in particular, of answering two sets of questions. Was the intensive peer interaction typical of RTTP games associated with an increase in the number of ties between students? If there was an increase in ties, did those ties tend to be exclusive, in the sense of being either homophilous (restricted to in-clique ties among EA students or RTTP factions) or triangle-completing? We answered the first question by simply counting the net increase in ties after each RTTP game, and answered the second question by modelling network change using exponential random graph models (ERGMs) with terms for homophily and triadic ties (GWESP).

We observed the following network changes:

1. Ties between students in both the acquaintance and friendship networks tended to increase during each game.
2. There were more added ties in the acquaintance networks than in the friendship networks.
3. Added ties eliminated social isolation in the class. After the first game all students had developed multiple acquaintance ties and at least one friendship tie.
4. Added ties did not tend to be exclusive. In contrast to the EA group's propensity for homophily before the first game, ties added by these students during the games were not exclusive. Further, the coefficients for GWESP, the variable capturing the tendency to form ties that complete triangles, was not significant in our models of the dynamic networks. (The one exception was for friendship ties added during the third game.) And while students in factions did display a propensity for homophily in the acquaintance and friendship ties added during the first game, they displayed no such propensity in the second and third games.

The overall picture emerging from this study, then, is that students formed numerous relationships during the games, relationships that eliminated social isolation in the class but did not tend to reinforce existing cliques or, for the most part, to create new ones. The classroom networks were extremely dynamic. While the acquaintance networks grew more than the friendship networks did, both became denser with each game. In short, a tight-knit but open and inclusive classroom community formed during the games—far more open and inclusive, certainly, than the one at the beginning of the semester.

From the perspective of social capital theory, the development of this sort of classroom community is an important outcome, particularly for first-year students: these networks provide students with social capital, facilitating the circulation of resources, particularly new information and ideas, contributing to their academic performance. Such social capital would benefit students within a class where strong acquaintance networks, in addition to friendship networks, provide them with intellectual challenge, thereby broadening their perspectives and guarding against groupthink (Bruffee, 1993; Burt, 2005; Granovetter, 1983; Jaffee, 2007). Students with acquaintance ties are in a better network position for learning, especially for learning to think critically. Such relationships might also benefit them in the years following a class as they navigate complex college environments. (One can imagine, for example, acquaintances exchanging performance-influencing information—about classes to take, advisors to talk to,

requirements to satisfy—while chatting in passing on campus.) Bonding social capital is also clearly important in the classroom environment. Tinto (1997), of course, emphasizes the value of friendship ties for providing first-year students with support. The class observed in this study developed networks rich in bonding and bridging forms of social capital.

We suggest that such networks are a signature of collaborative learning approaches like RTTP and would not typically form in traditional classrooms. Bruffee's (1993) temporary consensus groups involve randomly and regularly mixing students in groups. Pedagogical approaches that require this sort of mixing, we submit, will likely result in highly dynamic networks having the properties we observed in the RTTP class. By contrast, our account of traditional classrooms—static seating and no inducement to mix across cliques—suggests that students in such classrooms may not similarly "enlarge their acquaintance" (p. 39). The social structural signature of traditional pedagogy would be small, unconnected cliques, with many isolated students, and little evolution through time.

There are limitations to this study. Our dataset was small and unrepresentative, which obviously complicates the generalizability of our results. For this reason, we tried to avoid over-fitting, focusing on simple models exploring clear patterns in our data. The social structural changes associated with RTTP games will likely vary with institutional context, game topic and structure, the number of games, the timing of the game during the semester, the number and intensity of prior relationships among students, the teacher, and the type and mix of students. Nevertheless, we think that our results, buttressed by social capital theory and the observed effects of collaborative learning in other contexts, support a hypothesis about the typical pattern of network development associated with RTTP games as well as the mechanism for that development: non-exclusive ties between students increase with increased opportunities for student interaction across clique boundaries. One specific caution is in order, however. The opportunity structure for tie formation diminishes as a network grows denser. In the case of EA students, for example, dense intra-group ties at the beginning of the semester meant that there were fewer opportunities later on for adding more such ties. It is hard to know to what extent the non-significant coefficients for EA homophily in the models of the dynamic networks might have been influenced by this reduced opportunity structure.

CONCLUSION

This exploratory study does not allow us to predict the social structural changes associated with RTTP in any given class—the changes will surely differ in a variety of ways from those reported here—but it does offer evidence for our hypothesis that teaching approaches like RTTP tend to build dense, inclusive classroom networks by structuring opportunities for students to form ties that cut across clique boundaries. Such relationships, we argue, likely benefit students educationally not only in the classroom as they are challenged by different perspectives, but also beyond the classroom as they gain information from peers helping them navigate complex systems of higher education. We emphasize that our purpose in this study was not establish a link between student learning and classroom network structures. Rather, we conditioned our study on the notion that there is a link (a notion well-supported by the literature discussed above) and sought instead to develop a hypothesis about the relationship between these collaborative learning approaches and classroom network formation. Further research, we hope, will test our hypothesis by analyzing social networks in larger and more representative samples of classes utilizing collaborative pedagogies like RTTP.

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NOTES

1. For further technical details on ERGMs, see Lusher et al., 2013 and Hunter & Handcock, 2008.
2. By "increase in ties," we mean the number of new directed edges minus the number of old edges that have disappeared.
3. The lack of new friendship ties during the second game was most likely due to missing responses. Two students did not complete the third survey. If their reported ties had remained constant, there would have been an increase of 13 ties.
4. In ERGMs, the Edges term is equivalent to the intercept in a linear model. EA ties and Faction ties can be thought of as main effects for the propensity of students in these groups to form ties, while the homophily variables—EA homophily and Faction homophily—are like interactions, exploring the question: Does the propensity for students in these groups to form ties vary with whether the tie is within-group?
5. We checked goodness-of-fit for all models reported here and found it to be satisfactory.
6. The coefficients reported in Tables 3 and 4 represent the log-odds of a tie. In the pre-game acquaintance network, the log-odds of adding a tie that completed a triangle between EA students was -.6 + 1.75 = 1.15, and in the friendship network the log-odds was 1.48 + 1.78 = 3.26. For interpretation, it is convenient to convert coefficients to odds ratios by exponentiating them. Thus, in the acquaintance network, $e^{-.60+1.75} = 3.16$, indicating a 216% increase in the odds of such a tie compared to one that did not complete a triangle and was not EA exclusive, and in the friendship network, $e^{1.48+1.78} = 26.05$, indicating a 2505% increase in the odds. In subsequent paragraphs in the text we express these large percentages as simple multiples. In this case, a 216% increase in odds is described as "about 2 times more likely" and 2505% increase is described as "about 25 times more likely."

REFERENCES

Astin, A. W. (1993). What matters in college? *Liberal Education*, 1–4.

Bowman, N. A. (2010). College diversity experiences and cognitive development: A meta-analysis. *Review of Educational Research*, *80*(1), 4-33.

Bruffee, K. (1993). *Collaborative learning: Higher education, interdependence, and the authority of knowledge*. Baltimore, MD: The Johns Hopkins University Press.

Burney,J., Powers, R.G., & Carnes, M. (2010). *Reacting to the Past: A New Approach to Student Engagement and to Enhancing General Education*. White Paper Report. New York, NY: Teagle Foundation.

Burt, R. (2005). *Brokerage and closure: An introduction to social capital*. Oxford: Oxford University Press.

Carnes, M. C. (2011, March). Setting students' minds on fire. *The Chronicle of Higher Education*. Retrieved from http://chronicle.com/article/Setting-Students-Minds-on/126592/.

Carnes, M. C. (2014). *Minds on fire: How role-immersion games transform college*. Cambridge, MA: Harvard University Press.

Christakis, N., & Fowler, J. H. (2008). *Connected: The amazing power of social networks and how they shape our lives*. New York, NY: HarperCollins Publishers.

Cooley, C. (1962). *Social Organization*. New York, NY: Schocken.

Costenbader, E. (2003, October). The stability of centrality measures when networks are sampled. *Social Networks*, *25* (4), 283–307.

Curşeu, P. L., & Pluut, H. (2013). Student groups as learning entities: The effect of group diversity and teamwork quality on groups' cognitive complexity. *Studies in Higher Education*, *38*(1), 87-103.

Davis, J., & Leinhardt, S. (1974). The structure of positive interpersonal relations in small groups. In J. Berger (Ed.), *Sociological theories in progress, volume 2* (pp. 218-251). Boston, MA: Houghton Mifflin.

Dewey, J. (1938). *Experience and Education*. New York, NY: Collier Books.

Deci, E., Vallerand, R., Pelletier, L., & Ryan, R. (1991, June). Motivation and education: The self-determination perspective. *Educational Psychologist*, *26* (3), 325-346.

Driscoll, M., Dunn, E. E., Siems, D. P., & Swanson, B. K. (2014). *Charles Darwin, the Copley Medal and the rise of naturalism, 1861-64*. New York, NY: W. W. Norton.

Farrington, C. A. (2013). *Academic mindsets as a critical component of deeper learning: A white paper prepared for the William and Flora Hewlett Foundation.* Chicago, IL: Consortium on Chicago School Research.

Farrington, C. A., Roderick, M., Allensworth, E., Nagaoka, J., Keyes, T. S., Johnson, D. W., & Beechum, N. O. (2012). *Teaching adolescents to become learners: The role of noncognitive factors in shaping school performance--A critical literature review*. Chicago, IL: Consortium on Chicago School Research.

Good, C., Aronson, J., & Inzlicht, M. (2003). Improving adolescents' standardized test performance: An intervention to reduce the effects of stereotype threat. *Journal of Applied Developmental Psychology*, *24*(6), 645-662.

Good, C., Rattan, A., & Dweck, C. S. (2012). Why do women opt out? Sense of belonging and women's representation in mathematics. *Journal of personality and social psychology*, *102*(4), 700.

Goodreau, S. M., Kitts, J. A., & Morris, M. (2009). Birds of a feather or friend of a friend? Using Exponential Random Graph Models to investigate adolescent social networks. *Demography*, *46* (1), 103–125.

Granovetter, M. (1983). The strength of weak ties: A network theory revisited. *Sociological theory*, *1* (1983), 201–233.

Hunter, D., & Handcock, M. (2008). ergm: A package to fit, simulate and diagnose Exponential-family Random Graph Models for networks. *Journal of statistical software*, *24* (3).

Jaffee, D. (2007). Peer cohorts and the unintended consequences of freshman learning communities. *College Teaching*, *55* (2), 65–71.

Kadushin, C. (2012). *Understanding social networks: Theories, concepts, and findings*. New York, NY: Oxford University Press, USA.

Kates, G., & Carnes, M. C. (2014). *Rousseau, Burke, and Revolution in France, 1791*. New York, NY: W. W. Norton.

Lee, P., & Ashby, R. (2000). Progression in historical understanding among students ages 7-14. In P.N. Stearns, P. Seixas, & S. Wineburg, (Eds.), *Knowing teaching & learning history: National and international perspectives*. New York, NY: New York University Press.

Lee, P. (2004). Understanding history. In P. Seixas (Ed.) *Theorizing historical consciousness* (pp. 129-164). Toronto, Canada: University of Toronto Press.

Lusher, D., Koskinen, J., & Robins, G. (Eds.). (2013). *Exponential random graph models for social networks*. New York, NY: Cambridge University Press.

Maslow, A. (1943). A theory of human motivation. *Psychological Review*, *50* (4), 370-96.

McKinney, J. P., McKinney, K. G., Franiuk, R., & Schweitzer, J. (2006). The College classroom as a community: Impact on student attitudes and learning. *College Teaching*, *54* (3), 281-284.

McPherson, M., & Smith-Lovin, L. (2001). Birds of a feather: Homophily in social networks. *Annual Review of Sociology*, *27*, 415–444.

Osterman, K. F. (2000). Students' need for belonging in the school community. *Review of Educational Research*, *70* (3), 323–367.

Pascarella, E. T., & Terenzini, P. T. (2005). *How college affects students. Volume 2: A third decade of research*. San Francisco, CA: Jossey-Bass Publishers.

Pascarella, E. T., & Blaich, C. (2013). Lessons from the Wabash National Study of Liberal Arts Education. *Change: The Magazine of Higher Learning*, *45*(2), 6-15. Retrieved December 19, 2013, from www.changemag.org/Archives/Back Issues/2013/March-April 2013/wabash_full.html

Pike, G. R., Kuh, G. D., & McCormick, A. C. (2010, October). An investigation of the contingent relationships between learning community participation and student engagement. *Research in Higher Education*, *52* (3), 300-322.

Purnell, F. J., Pettersen, M. S., & Carnes, M. C. (2014). *The trial of Galileo: Aristotelianism, the "New Cosmology," and the Catholic Church, 1616-33*. New York, NY: W. W. Norton.

Putnam, R. D. (2000). *Bowling alone: The collapse and revival of American community*. New York, NY: Simon & Schuster.

Shaw, M. (1971). *Group dynamics: The psychology of group behavior*. New York, NY: Mcgraw-Hill.

Summers, J. J., & Svinicki, M. D. (2007). Investigating classroom community in higher education. *Learning and Individual Differences*, *17* (1), 55–67.

Tinto, V. (1997, November). Classrooms as communities: Exploring the educational character of student persistence. *The Journal of Higher Education, 68* (6), 599-623.

Valente, T. (2010). *Social networks and health: Models, methods, and applications*. New York, NY: Oxford University Press.

Vygotsky, L. S. (1958). *Mind in society: the development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Walton, G. M., & Cohen, G. L. (2007). A question of belonging: race, social fit, and achievement. *Journal of personality and social psychology, 92* (1), 82-96.

Walton, G. M., & Cohen, G. L. (2011). A brief social-belonging intervention improves academic and health outcomes of minority students. *Science, 331*(6023), 1447-51.

Wasserman, S., & Faust, K. (1994). *Social network analysis: Applications and methods*. Cambridge, UK: Cambridge University Press.

Yeager, D. S., & Walton, G. M. (2011). Social-psychological interventions in education: They're not magic. *Review of Educational Research, 81*(2), 267-301.

Zhao, C.M., & Kuh, G. D. (2004, March). Adding value: Learning communities and student engagement. *Research in Higher Education, 45*(2), 115–138.