Understanding emerging knowledge spillovers in small-group learning settings: The role of project-based learning, friendship and work-relations

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Abstract

Learning in authentic projects is supposed to enhance graduates knowledge, skills and future employment. However, in programmes with a large number of students, implementing project-based learning and providing helpful guidance, extensive feedback, and support by teachers can be cumbersome. While peer assessment traditionally is used for grading or marking peers, there is a call for more formative (for learning) assessment and feedback using ICT which goes beyond marking and grading. This study took place in a post-graduate course on Event Operations management, whereby 69 primarily international students were divided into nine teams and worked together for a sustained period of fourteen weeks on a high-stake assignment, namely running a successful and profitable event. For ascertaining whether inter- and intra-team learning and knowledge spillovers occurred during the course, we employed a method developed within the field of Social Network Analyses (SNA). We measured prior friendship and work relations during the first week, while possible knowledge spillovers between learners and teams were assessed during week 14.

In contrast to previous research on evolution of knowledge spillovers in small-group settings by Hernandez Nanclares et al. (2012), our results seem to indicate that knowledge spillovers across teams reduced over time. While all nine teams had substantial work and friendship relations outside their own team at the beginning of the module, over time all teams became more focussed on learning within teams. While pre-existing friendship ties are significantly correlated to the post- measurements of learning and work networks, pre-existing work ties are more strongly correlated with learning ties after fourteen weeks, as confirmed by multiple regression quadratic assignment procedures. Although further research is needed to confirm the underlying dynamics why teams and learners became more internally focussed, we hypothesise that the instructional design (i.e. focus on competition) and task-assignment may have a stronger impact on reducing knowledge spillovers between learners and teams.

Keywords

Dynamic social network analysis, knowledge spillovers, project-based learning, peer assessment.

Introduction

In the last ten years, two major developments in higher education have added to the complexity of the role of academic scholars, namely the focus on employability of graduates and a shift towards student-centred learning. Several researchers have found that business schools do not prepare graduates for the real world of business (Gerken, Rienties, Giesbers, & Könings, 2012; Van den Bosch, 2008). Graduates have to adapt to a new working world when they enter the job market, e.g. applying their theoretical knowledge to a work-related

ISBN 978-1-86220-283-2

context. Both research and practice has found that graduates experience significant difficulties to transfer their acquired knowledge and skills into the real world when starting their first job (Tynjälä, 2008). The transition can be eased when graduates know what they are getting into (Gerken, et al., 2012). Several researchers (Gerken, et al., 2012; Van den Bosch, 2008) have argued that business schools should adopt certain features of work learning in order to integrate theory and practice. This can for example be achieved by allowing students to work on authentic projects (Belei, Noteborn, & De Ruyter, 2009; Thomas, 2000), either in cooperation with networks in the business world or in a real-world setting .

A second important development in higher education is that research evidence has shown that traditional teacher-centred forms of education, such as lectures, do not provide an optimal learning experience for all types of learners (Biggs & Tang, 2007; Hommes et al., 2012). In student-focussed teaching, the role of the teacher changes from knowledge transmission to learning facilitation (Biggs & Tang, 2007; Kember & Gow, 1994; Struyven, Dochy, & Janssens, 2011). Although a large body of research is available how teachers can create student-centred approaches, several researchers (Dochy, Segers, & Sluijsmans, 1999; Van Zundert, Sluijsmans, & van Merriënboer, 2010) have highlighted that the role of new assessment methods in student-centred learning is not well-understood and under-researched. Self-assessments and peer assessment can provide a rich and valuable learning experience for students, which can boost student self-confidence, stimulate self-reflection, lead to increased student satisfaction and improved performance (Dochy, et al., 1999; Van Zundert, et al., 2010). Recent research (Sluijsmans, Brand-Gruwel, Van Merriënboer, & Bastiaens, 2003; Van Zundert, et al., 2010) has looked into how self-assessment and peer assessment can help learners to reflect on their role within a group and their individual contributions to the group process and group product in both a formative and summative manner. While peer assessment traditionally is used for grading or marking peers using traditional pen- and paper, there is a call for more formative (i.e. for learning) assessment and feedback that goes beyond marking and grading using ICT. In a review on the current stance of research and practice into peer assessment, Van Zundert et al. (2010) urges new research to focus on how teachers can effectively implement innovative student-centred learning and assessment forms that lead to enhanced learning. The implication is that teachers need to have a greater range of assessment strategies using ICT available to them to meet the demands of a diverse group of learners.

We feel that the best description of the pedagogical approach used in the studied setting is Project Based Learning. In Project Based Learning, learning is organised around project. According to Thomas (2000, p. 1), "project are complex tasks, based upon challenging questions or problems, that involve students in design, problem-solving, decision-making, or investigating activities; give students the opportunity to work relatively autonomously over extended periods of time, and culminate in realistic products or presentations". That is, students, in groups of 7-8 students, have to run and organise a one-off event that is profitable via one of the suitable venues throughout the university (Tosey, McDonnell, & Dickenson, 2007; Willis, Alcott, & Rienties, 2011). By providing five online self-assessment and peer assessment opportunities, the teachers aimed to allow students sufficient opportunities to reflect on their individual and group processes and performance (Rienties, Willis, Alcott, & Medland, Submitted). Furthermore, by discussing the various stages about the project during the weekly two hour classroom meetings, we hoped that students would also learn from other students and teams. The primary goal of this research is to explore whether and how knowledge spillovers across project teams occurred over time and how researchers may capture these spillovers using social network analysis (Bohle Carbonell, Rienties, & Van den Bossche, 2011; De Laat, Lally, Lipponen, & Simons, 2007; Hernandez Nanclares, Rienties, & Van den Bossche, 2012; Hurme, Veermans, Palonen, & Järvelä, 2008). In this study, we want to know if knowledge is really transferred among learners (individual students and project teams) and how this transfer occurs inside and between teams. This study does so by applying a dynamic social network analysis in order to understand the dynamics of knowledge spillovers within and across teams in a pre-post test manner.

Method

Participants

The average age of the 69 participants was 22.99 (SD= 2.12) and 84% of participants was female. In contrast to paper 1 and paper 3, whereby most of the students were from the same cultural background as the institute, in this setting only three students were from the UK. 72% of the students were from Confucian Asian and Southern Asian countries, primarily China, Thailand and India. The third largest group of international students came from Eastern Europe.

ISBN 978-1-86220-283-2

Setting

An innovative blended learning environment was redesigned whereby 69 post-graduate/masters' students interacted in a project-based setting (See also Tosey, et al., 2007; Willis, et al., 2011). Nine small working teams were formed at random during the first meeting. 15 students from a "food management" specialisation were divided into Team 8 and Team 9. The remaining 54 students from the hospitality management program were divided into Team 1 – 7. The 54 and 15 students had worked together in different small groups within their specialisation in Semester 1 and knew each other for four months. During the 14 week course period, students met formally once a week during three-hour interactive class session. At the same time, students were expected to meet with the peers of their team during the week in order to work on three group processes/products.Van Zundert et al. (2010) argue that if teachers want to effectively implement peer assessment in the classroom, sufficient time and effort needs to be spend with students to discuss and explain how peer assessment works. Therefore, an initial training of the use of the ICT tool was provided during the first week. During the training, the students together with the teachers and instructional designer discussed in an open manner the potential advantages and challenges of working in groups in a project and using self-assessment and peer assessment. Every two-three weeks, each member of the group reflects upon his/her individual role within the group using the journal entry tool of WebCT three days before the next class-meeting.

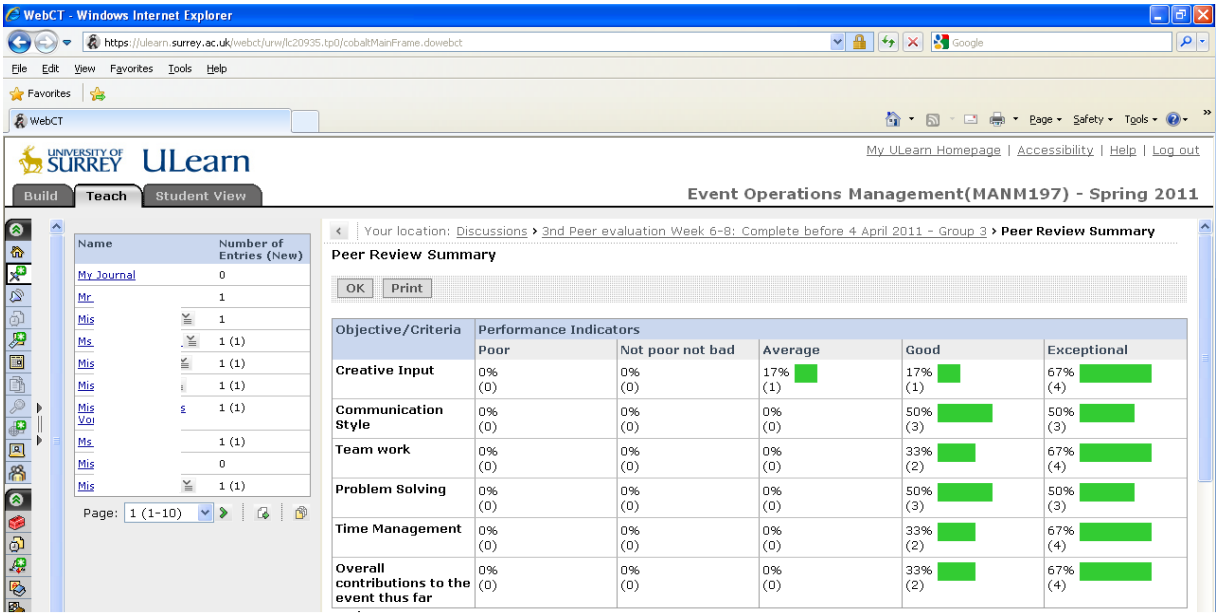

Figure 1 Screenshot of peer evaluation of student X

Two days before the next class-meeting, each member of the group conducts a peer rating of each member within the group on six categories (i.e. creative input, co-operation within the group, group-work, problem solving, keeping schedule, effectiveness of performance for event) on a Likert-scale ranging from 1-5, as is illustrated in Figure 1. For each category an extensive rubric is given what it means to be (for example) an excellent contributor to creative input. Students are also encouraged to provide open comments. Finally, on the day of the class-meeting students together with the teachers discuss the results of the self-assessment and peer assessment as well as the general progress of the project. In total five peer ratings are conducted during the 15 weeks. During the first three peer ratings, the results of the peer rating, the feedback given as well as the name of the student giving feedback is visible for the student receiving feedback. In the two follow-up peer ratings, feedback is provided anonymous to the respective student only. The first four peer evaluations are formative, primarily for individual reflection and learning. The final peer rating is summative and is implemented after the event was completed, whereby 25% of the final grade is determined by the average peer evaluation scores for each respective student. In Table 1, the design of the learning environment is illustrated, whereby a more detailed description of the learning environment is described elsewhere (Rienties, et al., Submitted; Willis, et al., 2011).

ISBN 978-1-86220-283-2

Social Network analysis of prior friendships and work-relations

For ascertaining whether inter- and intra-team learning and knowledge spillovers occurred during the module, we employed the method developed within by Hernandez-Nanclares et al. (2012). During the first meeting, the pre-existing friendship and work-relations were measured. During the last meeting after 14 weeks, the social networks measurements for learning, working and friendships were measured. The working network measures with whom students worked a lot during this module, while the friendships network measures with whom students were friends with (irrespective whether this was related to the module or not). Finally, the learning network measures from whom students have learned a lot during the module. For the pre-post measurements a response rate of 71% and 84% was established. The relatively lower response rate during the first measurement at the beginning of the module can be explained by the fact that some of the students were still at their home country in the first week of the module. During the post-measurement some of the participants were not present at the debriefing as they were working on their final thesis and were collecting data. Participants who were not present during the pre- and post-meeting were contacted via email twice to complete the questionnaire. In addition to measuring the E-I index (as described in paper 1), density and centrality of the whole networks were determined. Density compares to centrality by looking at the number of ties an actor has divided by the number of pairs of actors. Centrality looks at the amount of direct ties an actor has. Follow-up quadratic assignment procedure Pearson correlations (Hanneman & Riddle, 2005) were conducted in order to compare similarity measures between the friendship, working and learning networks, and assess the frequency of random measures as large as actually observed. Finally, multiple regression quadratic assignment procedures were used to test whether friendships and learning networks developed predicted learning networkers after 14 weeks.

Table 1 Teams' interaction opportunities and learning spaces

	Face-to-face learning space	Online Learning Space
Intra-team interaction	Teams work on their event feasibility plan (Group product 1) Discussing and reflecting Organising of final event (Group product 2) Final group reflection report (Group product 3)	Private team forum -Self-reflection tool -Peer-evaluation tool (see Figure 1) -Feedback and corrections through the forum -Feedback on group development after each peer evaluation by teacher(s)
Inter-team interaction	Presentations of the resulting products during module and final event Discussions Analysis and assessment of other teams' products	Public Discussion forum

Results

Prior friendship relations

In Figure 2, the friendship relations at the beginning of the module are visually illustrated. From the illustrations, as expected there are two clusters of students, whereby group 9 (red) group 10 (green) form different sub-groups, which is due to the fact that these two groups followed a separate specialisation in food management. On average, a student has 19.47 (SD = 11.95) friends at the start of the course, which is significantly different using Chi-Square test ($\chi 2$ (df = 66 N = 69) 445.46, $p < .001$), implying that students differed significantly in the number of friends at the start of the module. Furthermore, students had 13.71 (SD=8.41) prior work relations at the start of the course, which is again significant ($\chi 2$ (df = 64 N = 69) 275.28, $p < .001$). On average, a student is connected to 3.68 (SD =2.10) friends within its team, and no significant differences using Chi-Square are found. In contrast, students are connected to 15. 80 (SD = 10.87) friends outside their team, with significant Chi-Squares ($\chi 2$ (df = 66 N = 69) 462.19, $p < .001$). This implies that students have a similar amount of friends within each team, but the number of friends outside each team is significantly different. As the participants were from a range of cultural backgrounds, afterwards we compared whether relationships were primarily with students from similar or different cultures. Most students had more links to students from different cultural backgrounds, except for students from a Confucian Asian background, who had a negative E-I index of -.298. However, this result must be treated with caution given that the 55% of

ISBN 978-1-86220-283-2

the students were from this geographical region. The centrality measure indicates that participants have a direct friendship connection with 31% of other participants, which implies that some students have more friends than others. The overall density of the friendship is 20%, indicating a moderately strong developed friendship network.

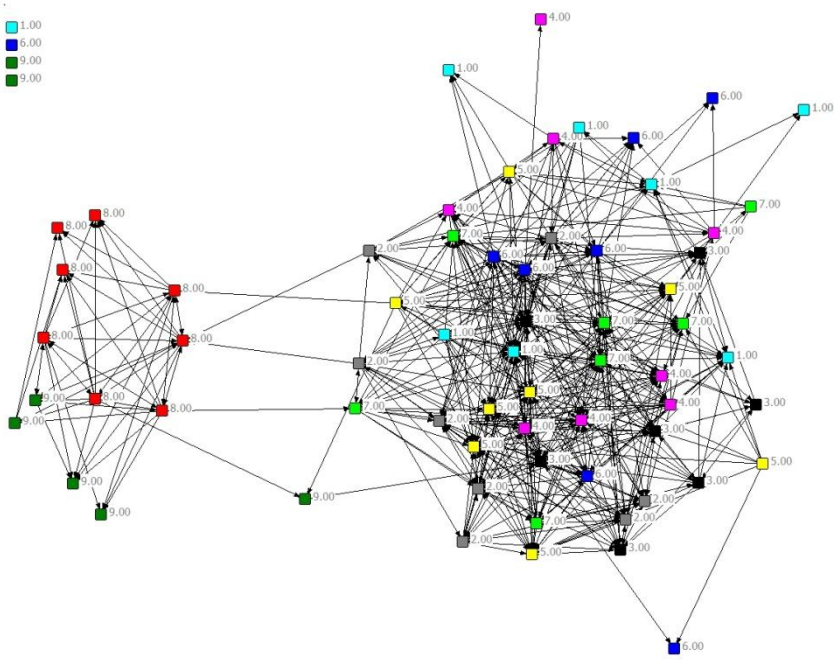

Figure 2 Pre-existing work relations

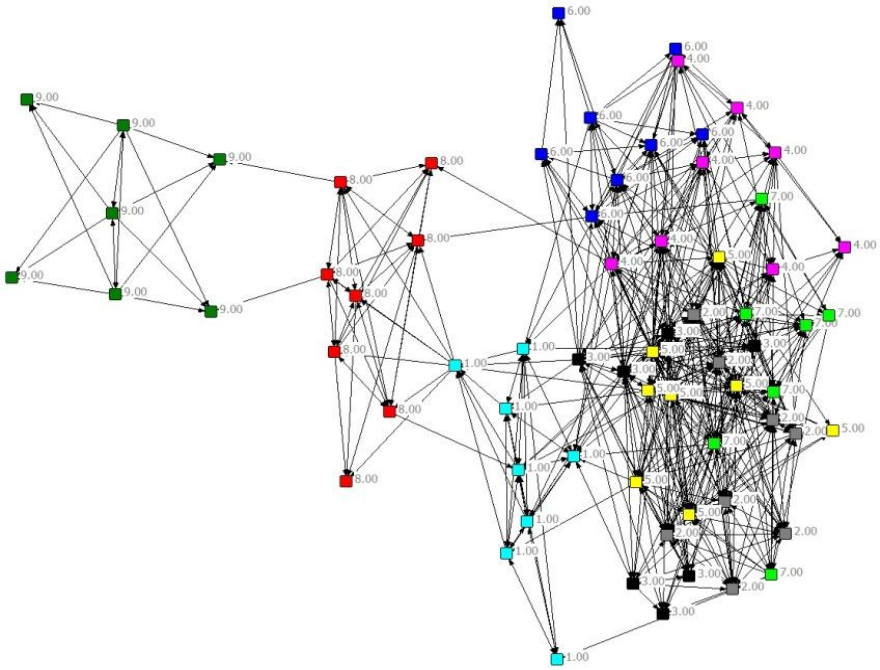

Figure 3 Work network after fourteen weeks

Social Network Analysis at end of module

At the end of the course, participants have an average of 22.46 (SD=10.18) friends, 11.68 (SD= 6.73) work relationship and indicate that they have learned from 10.15 (SD=5.62) other participants. The number of team members counted as friends has increased from 3.68 to 5.48 (SD = 1.52), which is a significant increase using a

paired-sample T-test (t = 6.869, p-value < 0.01). The number of friends outside the team remained the same over time. The number of work relationships within the teams increased from 3.25 to 5.83, which is also a significant increase (t = 10.698, p-value < 0.01). In contrast, the number of work relationships outside teams decreased significantly from 7.59 to 6.36 (t = -3.699, p-value < 0.01), as well as the E-I Index (t = -7.574, p-value < 0.01). As is also visually illustrated when comparing Figure 2 with Figure 3, students at the end of the module primarily worked with members of their own team, as the team structures (identified by colours and labels) were closer together in Figure 3 than in Figure 2. While food management students already were working primarily with peers from the same program from the start, after 14 weeks also the hospitality students were primarily working together with other team members. In addition, the learning network after 14 weeks primarily showed that students were learning foremost with their team members (not illustrated).

Table 2 Intra and inter team work relations (pre-post test)

	N	Work relations at beginning of module			E-I	Work relations at end of module			E-I
		Internal	External	Total	index	Internal	External	Total	index
Team 1	8	12	75	87	0.724	50	32	82	-0.22
Team 2	8	30	118	148	0.595	56	93	149	0.248
Team 3	7	36	92	128	0.438	40	83	123	0.35
Team 4	8	22	94	116	0.621	44	64	108	0.185
Team 5	8	34	114	148	0.541	54	121	175	0.383
Team 6	8	16	88	104	0.692	38	49	87	0.126
Team 7	7	26	95	121	0.57	40	66	106	0.245
Team 8	8	46	24	70	-0.314	50	12	62	-0.613
Team 9	7	2	22	24	0.833	30	2	32	-0.875
Average	69	25	80	105	0.522	45	58	103	-0.019

Table 2 shows the number of external and internal work ties per team with regard to whom team members at the beginning and end of the module were connected to. At the beginning of the module, all teams have a preference to work with members outside their team, except Team 8. All other teams have stronger links to students outside the team, which is rather intuitive as students were randomly assigned to groups. After 14 weeks, the number of work ties has reduced from 105 per team to 103. Furthermore, the balance of external and internal links has shifted in favour to internal team links. All teams develop more significant internal work relations over time using paired sample T-testing on a team level (t = 3.728, p-value < 0.01), as is illustrated in both the number of internal links as well as significant lower E-I index scores (t = -3.520, p-value < 0.01). Some teams (Team 1, 8 and 9) develop primarily internal work relations, as is also visually illustrated in Figure 3 by their relative separate cluster position. Finally, the patterns of social friendship relations influenced by cultural differences remained the same as at the start of the module, whereby only Confucian Asian students developed stronger relationships with other Confucian Asian students.

Table 3 QAP Pearson Correlation Results for Friendship, work relationship and learning network

	M	SD	Density (in %)	1	2	3	4
1. Friendship ties (M1)	19.48	11.95	19.67				
2. Friendship ties (M2)	22.46	10.18	23.00	.457***			
3. Work ties (M1)	13.71	8.40	12.15	.561***	.347***		
4. Work ties (M2)	13.39	6.88	13.62	.313***	.588***	.299***	
5. Learning ties (M2)	10.15	5.62	10.16	.254***	.472***	.273***	.623***

*** correlation significant at the 0.001 level

In Table 3, the friendship and learning ties during the fourteen weeks are illustrated, as well as the density scores for the entire classroom and the correlations between the pre- and post-test social networks using UCINET QAP correlation (Hanneman & Riddle, 2005). The friendship ties are significantly correlated to the three

ISBN 978-1-86220-283-2

measurements of learning and work networks. However, pre-existing work ties are more strongly correlated with learning ties after fourteen weeks in comparison to friendship ties. Finally, using multiple regression quadratic assignment procedures, learning ties after 14 weeks are significantly predicted by friendship ties, with an adjusted R-square of 0.06, as is illustrated in Table 4 by Model 1. Adding the work ties significantly improves the fit in Model 2. That is, learning ties after 14 weeks are significantly predicted by pre-existing friendship and work ties, with an adjusted R-square of 0.10. When including friendship ties at the end of the module in Model 3, the predictive power of pre-existing friendship ties disappears. In Model 4, initial and work ties developed over the module are primary predictors for learning ties. Finally, in Model 5, a small but significant effect for culture is found, although the overall fit of the model and the standardised betas for the four matrixes remain the same, implying that the underlying learning processes remain the same.

Table 4 Regression analysis of academic learning networks with friendship and work ties

	Learning network after 14 weeks				
	Model 1	Model 2	Model 3	Model 4	Model 5
Friendship ties (M1)	0.25***	0.15***	-0.02	-0.02	-0.02
Work ties (M1)		0.19***	0.13***	0.08***	0.08***
Friendship ties (M2)			0.44***	0.15***	0.15***
Work ties (M2)				0.52***	0.52***
Culture					0.04*
R-Squared-adjusted	0.06	0.1	0.24	0.41	0.41

*** $p < 0.001$, * $p < 0.05$.

Discussion

In this paper we explored the dynamic evolution of friendship, working and learning ties in an innovative post-graduate module, whereby primarily international students worked together in a project-based learning setting creating a profitable event. In contrast to Hernandez Nanclares et al. (2012) and findings from paper 1, who found that students over time develop more knowledge spillovers with students outside their own team, our findings seem to indicate that relationships in teams over time became more internally focussed. That is, over time students developed more links with members of their own team. Also, these results seem to be substantially different from the findings by Hommes et al. (2012) and paper 3, who found that first-year medical students who worked together for 6 modules in a range of different groups primarily learn with students outside their own current group.

A possible reason for this is the instructional setting is substantially different from paper 1 and paper 3. Teams in paper 1 and 3 are not (directly) in competition between each other and thus students will not harm the performance of their team by sharing their knowledge with other teams, while teams in our setting were competing for a similar market of customers to attend their events. A second reason may be that most students in the food specialisation and hospitality management specialisation were already familiar with each other and had already worked for one semester together. As highlighted by Wheelan (2004), it takes up to two to four months for teams to effectively work together and most teams had a sufficient number of friends within the team to further build on. Another reason for the contradictory findings by Hernandez Nanclares et al. (2012) might be that the cultural differences in our setting are more heterogeneous. That is, while in paper 1 only 7 international students were present, in this paper most students came from overseas, in particular China. As the largest group of Chinese students had a preference of 38% to work with other Chinese students, which may impact knowledge sharing across different cultures. Previous research has already found that international students prefer to work together with students from similar cultural backgrounds (Bochner, McLeod, & Lin, 1977; Rienties, Beausaert, Grohnert, Niemantsverdriet, & Kommers, 2012; Russell, Rosenthal, & Thomson, 2010). Finally, future research should investigate whether these social networks influence learning outcomes in a similar manner as Hommes et al. (2012), who found that informal social networks were the primary predictor for academic performance.

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