Using social networking environments to support collaborative learning in a Chinese university class: Interaction pattern and influencing factors

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This paper reports a study that investigated the social interaction pattern of collaborative learning and the factors affecting the effectiveness of collaborative learning in a social networking environment (SNE). A class of 55 undergraduate students enrolled in an elective course at a Chinese university was recruited for the study. The participants used an SNE to support their learning activities over a semester. Data was collected through interviews, classroom observations, and from digital artifacts created in the SNE. Social network analysis and content analysis were adopted to analyze data. The results showed that social interaction in the SNE tended to be teacher-centered, social-oriented, fragmented, and short-lived. Pre-existing social relations, perceptions of the teacher and peer feedback, preferred learning approaches and collaboration strategies, nature of the task, and the individualistic nature of social networking technology were factors that influenced how students interacted with each other in collaborative learning mediated by the SNE. The findings have both practical and theoretical implications.

Introduction

Social networking websites (SNSs) are web services that allow users to construct a public or semi-public profile and articulate a list of relationships with other users for the purpose of socialization (Boyd & Ellison, 2007). Social networking brings individuals together in specific groups, and as such is a form of social action. Social action refers to when "the acting individual takes account of the behavior of others and is thereby oriented in its course" (Secher, 1962, p.4). Specifically, an SNS creates a social networking environment (SNE) that enables users to describe who they are, create social connections with people with whom they have offline relationships or share common interests, and finally build varied online social networks (Tu, Blocher, & Roberts, 2008). It usually combines a range of social networking tools including, but not limited to, blogs, wikis, social bookmarks, really simple syndication (RSS), and social networking facilities (e.g., the friend list). The popularity of SNSs is on the increase around the world, particularly among a vast number of young people.

Practitioners and researchers have directed much attention to the educational potential of SNSs in enhancing learning and teaching in higher education (e.g. Hsu, 2007; McLoughlin & Lee, 2007). Social networking technology offers a wide range of affordances that facilitate social interaction, namely, content creation, collaborative information discovery and sharing, social relationship establishment and management, and information aggregation (Bryan, 2006; McLoughlin & Lee, 2007). Effective integration of a computer-mediated communication (CMC) tool into teaching and learning is possible only if educational affordances of the selected technology are in alignment with the requirement of learning tasks (Bower, 2008). Social interaction mediated by SNEs in the learning context, however, has not yet been sufficiently examined to inform teachers' pedagogical decision making in practice. Besides, previous studies have revealed the gap between expected and achieved learning outcomes and have called for further investigation into student perspectives on the educational use of social networking technology to help teachers purposefully design instructional guidance (e.g. Cole, 2009; Deng, 2010; Xie & Sharma, 2005). In view of this, the present study aims to gain an in-depth understanding of students' collaborative learning experience in an SNE, with a focus on the interaction pattern and related influencing factors in the context of higher education. A combination of social network analysis (SNA) and content analysis was employed to reveal structural and qualitative characteristics of social interaction of collaborative learning in the SNE.

Effective social interaction for collaborative learning

Social interaction is crucial to fruitful learning. Several characteristics of social interaction ensure the effectiveness of collaborative learning to a large degree. First, social interaction should be an active and sustained social process. Cognitive conflict plays a vital role in facilitating cognitive changes (Garton, 1992). In view of this, by actively taking place in social interaction for a sufficient period of time, students can obtain more opportunities to discover variance between different understandings, creating a condition in which cognitive conflict is more likely to arise. A dense social network built upon continuous social interaction may benefit information sharing and knowledge construction (Lipponen, Rahikainen, Lallimo, & Hakkarainen, 2003; Wellman, 1996).

Second, social interaction should induce higher-order thinking. Social interaction itself cannot automatically result in deep and meaningful learning. In the course of collaborative learning, students are expected to move beyond their existing levels of understanding through a range of cognitive activities, such as elaborating, explaining ideas and concepts, questioning, argumentation, resolving conceptual discrepancies, and metacognitive regulation of the learning process (Gunawardena, Lowe & Anderson, 1997; King, Fischer, Kollar, Mandl, & Haake, 2007; Veldhuis-Diermanse, 2002). To facilitate the above-mentioned learning activities, collaborative learning should be interactive and negotiable (Dillenbourg, 1999).

Third, social interaction should facilitate the socio-emotional aspects of group dynamics. Kreijns, Kirschner, & Jochems (2003) made a distinction between two types of mediated social interaction in educational situations: socio-cognitive and socio-emotional processes. The socio-emotional dimension of collaborative learning has been less studied, but has received increasing attention in recent years. The socio-emotional process of social interaction creates a sense of learning community in which students are willing to take the possible risk of being misunderstood as a result of arguing, offering tentative ideas or critiquing others' ideas, and to devote time and energy to collaborative learning (Rovai, 2002; Kreijns, 2004). At the same time, it appears problematic if social interactions are primarily socio-emotionally driven and consequently lack insights.

The present study

Different CMC tools have their own advantages and weaknesses in supporting certain forms of social interaction. Existing empirical evidence in terms of the social interaction patterns mediated by SNEs seems inadequate to illuminate the pedagogical role of SNEs in supporting collaborative learning. This study aimed to make a contribution in this respect by investigating the social interaction pattern of collaborative learning in an SNE and exploring the factors that influenced how students interacted with each other. Specifically, two main research questions guided the study:

> Q1: How do students interact with each other in a social networking environment?
>
> Q2: What are the factors that influence the social interaction pattern of collaborative learning in a social networking environment?

Method

Design of the study

A class of 55 undergraduate students enrolled in an elective course at a Chinese university served as the participants of the study. The primary objective of the course, "Introduction to Career Exploring and Planning for Undergraduate Students", was to assist undergraduate students in developing a long-term as

well as a flexible plan consisting of steps necessary to pursuing personal career goals. The participating students were studying in ten majors in different years of study. Most of them only knew a few of their classmates. The course consisted of 20 classroom sessions, including lectures, workshops, a mid-term examination, and tutorials over six months. Each session lasted about two hours. Due to the limited opportunity for face-to-face socialization, there was a need for an online social networking medium to enable students to introduce themselves to the others and communicate with those they did not know previously. Among the participants, 35 were female and 20 were male. Each student was required to develop a learning portfolio containing at least four individual assignments and one final essay. In addition, they were asked to form groups of three or four on their own to collaborate on a project. Table 1 describes the content and requirement of all tasks in the course.

Table 1
Course assignments

Task	Content and requirement
Individual Assignment 1	Assessing one's personality with software; documenting and interpreting assessment results in terms of advanced self-knowledge as well as future career options.
Individual Assignment 2	Describing important events occurring in one's life and exploring their personal meanings for individual development.
Individual Assignment 3	Analyzing the results of Vocational Card Sort to explore one's career preference.
Group project Report	Interviewing a professional in an occupational area and discussing what had been learnt from others' work experience.
Individual Assignment 4	Describing specific activities in one's typical day and the amount of hours spent to develop consciousness of time management
Final Essay	Elaborating one's self-understanding and career knowledge, describing the process of making a career decision and designing detailed steps towards setting career goals.

To support learning activities in this course, a social networking platform was implemented based on open-source software Elgg (see http://elgg.org/). The main structure of the platform is presented in Figure 1. The "Portfolio", which combined blogs, wikis, social bookmarks, and file repositories, offered students a place where they could archive and share digital resources, present ideas, share tasks they had completed, and receive feedback. The networking tools allowed students to make online friends by adding peers into friend lists ("Your Friends"), create collaborative space for group projects ("Your groups"), and be informed of the latest updated content within the class ("Latest activities"). The functions of "Your Friends" and "Your Profile" assisted students in socialization and development of individual networks within the class.

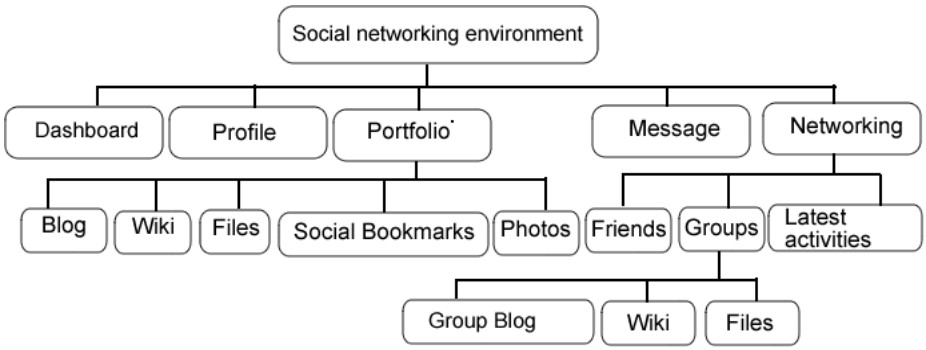

Figure 1. The main structure of the social networking environment.

Drawing upon the literature on the educational use of social networking technology, the design of online learning activities was intended to involve students in reflective thinking to construct self-understanding as well as occupational knowledge, and in exchanging ideas and emotional support. Previous studies suggest that students are cognitively engaged when blogs are used as a medium to elaborate ideas, record the learning process, and document reflections (e.g., Baggetun & Wasson, 2006; Dippold, 2009; Sim & Hew, 2010). In view of this, all assignments were required to be written on personal blogs residing in Portfolios. That gave students the opportunity to receive suggestions and critical feedback from peers (Xie, Ke, & Sharma, 2008). In addition, students were encouraged to utilize any tools that could meet their learning needs, such as social bookmarks to share reading materials and exchange comments. As for group projects, the group space was strongly recommended as a place of collaboration. The only restriction imposed on the collaborative approach and choice of media was that a wiki page had to be created for co-authoring group reports. It was expected that wikis would induce higher-level thinking by facilitating collaborative writing (e.g., Cress & Kimmerle, 2008; Matthew & Felvegi, 2009). Particular efforts were made to facilitate the socio-emotional dimension of communication. To promote socialization within the class, students were encouraged to compose profiles and make online friends on the platform. The students' social interaction was not subject to formal assessment. Instead, additional points were granted to active students as rewards. It was hoped that through loosely linking online social interactions with the assessment, students could not only freely express their emerging feelings but also offer emotional support to peers.

Data collection

Data were collected from interviews, classroom observations, and digital artifacts created by the students in the SNE. Except for one session for mid-examination, the rest (19 classroom sessions) were attended to directly observe classroom activities. Interviews were conducted in an informal and semi-structured manner. Informal interviews were short conversations with students, occurring after the phenomenon that drew the researcher's attention. The majority of the interviewees were invited to talk about their learning situation, or what was going on within the class. The purpose of the informal interviews was two-fold: firstly, they helped formulate subsequent questions for the semi-structured interviews; secondly, they kept the researcher as an insider of their learning community. Semi-structured interviews were conducted with 15 chosen participants who offered a range in terms of interaction patterns in the SNE. Examples of the interview questions were: Why did you interact with the others in this particular way? How do you think social interaction in the SNE relates to your learning? What factors affect social interaction in the SNE? All types of digital artifacts created in the SNE were collected, including blog posts, wiki pages, files uploaded to file repositories, social bookmarks, and comments. Data from different sources were triangulated to strengthen the validity of the emerging findings.

Data analysis

Data analysis adopted a mix of qualitative and quantitative methods. For qualitative data derived from the interviews and classroom observations, analysis was an ongoing and iterative process. Units of meaningful segments of data were sorted into categories.

Two steps were taken to analyze the artifacts created in the SNE. The first step was to identify in what ways social interactions took place. It turned out that commenting was adopted as the major channel of direct social interaction. In the second stage, all the comments collected in the SNE were examined through content analysis and SNA. Comments were coded in an effort to illuminate what characterized the socio-emotional and socio-cognitive interactions of the collaborative learning. The coding framework is presented in Table 5.

In addition, SNA was undertaken to investigate the structural attribute of social interaction patterns. SNA is an analytical framework characterized by a coherent set of principles in terms of relational conceptions and processes (Wasserman, 1994). Applying SNA to the social interaction mediated by CMC technologies has offered insights about participatory and relational aspects of collaborative learning in

recent research (e.g. Martinez, Dimitriadis, Gomez-Sanchez, Rubia-Avi, Jorrin-Abellan, & Marcos, 2006; Shen, Nuankhieo, Huang, Amelung, & Laffey, 2008). To perform SNA, a two-dimensional matrix indexed by comment senders and receivers was developed. The number of comments directed from one student to another was calculated as a measurement of social ties, and was applied to each pair of students. An adapted version of the coding framework of Manca, Delfino, and Mazzoni (2009) was applied to identify comment senders and receivers in social interactions (see Table 2). Based on the matrix, two chosen measures were calculated:

- Density: This measures the extent to which all possible social ties are actually presented in a social network (Scott, 1991). In this instance, it indicated the extent to which all the class members were connected through social interactions.
- Clustering analysis: The Girvan-Newman algorithm detects cohesive subgroups "in which network nodes are joined together in tightly knit groups, between which there are only looser connections" in a complex social system (Newman & Girvan, 2004, p.026113-2). In this study, it revealed how students clustered into cohesive subgroups based on the frequency of social interactions. The number of cohesive subgroups also indicates to what extent the network was fragmented (Wasserman, 1994).

Table 2
Coding scheme for identification of comment senders and receivers

Situation		Social ties
Step 1	Step 2	
(a) Student S posted an artifact and;	(a1) No one replied.	Ignored
	(a2) Student P replied to it by commenting.	P=>S
	(a3) Student P attached a comment following the S's artifact, but it actually replied to A's comment written to S.	P=>A
(b) Student S received comments on his/her artifacts and wrote a reply	(b1) The replying comment was addressed to the receiver P explicitly or implicitly.	S => P
	(b2) The replying comment was not addressed to the receiver, and students, for example, A, B, C, had commented on S's artifact.	S =>A S =>B S =>C
	(b) The replying comment was replied to by P.	P=>S S=>P (if this was the first comment P attached to the artifact)

Procedure

Before the first lecture, the teacher set up his space and created an account for each student. Throughout this course, he regularly used his blog to publish course announcements, share learning resources, and post after-class reflections. His file repository was utilized to upload and share relevant documents and software. Taking the role of facilitator, he regularly viewed students' learning portfolios and commented

on their work. In class, he occasionally remarked on issues of disengagement, or gave credit to good learning performance observed in the SNE so as to motivate and sustain participation.

In the first lecture, the researcher spent about an hour introducing the functionality of the platform and answering questions from the students. He elaborated how the social networking tools in the SNE could be applied to support a variety of learning activities. Then, the teacher emphasized the importance of social interaction for learning and the educational benefits of using the platform. A paper-based instruction was handed out to students briefly explaining how to use the platform, with the email address and Tencent QQ (instant messaging software) account of the researchers. As a warm-up exercise, students were asked to write at least two comments to their peers after the first assignment was submitted. Just after they had decided on the groups for the projects, the researcher demonstrated again how the wiki page could be created and edited collaboratively.

Results

How do students interact with one another in a SNE?

Table 3 shows the number of different types of artifacts and associated comments written by students in individual portfolios. It is not surprising that blogs (M = 4.69, SD = 1.95) were the most frequently used tools compared with the wiki (M = 0.15, SD = 0.52), bookmarks (M = 0, SD = 0) and file repositories (M = 0.29, SD = 0.75), since students were required to use blogs to write all their individual assignments. Collaborative writing never took place in the wiki. Altogether, there were 314 comments exchanged in the portfolios. 98.73% (n = 314) of them were attached to blog posts, and the rest to items in file repositories. A total of 38 (12.10%, n = 314) comments were written in the instructor's space. The teacher wrote a total of 79 comments to students.

There were a total of 15 group spaces set up for group projects. Unfortunately, no direct social interaction was observed in them, either in the form of commenting or in the form of collaborative editing. Although the researcher had demonstrated how wiki pages could be used collaboratively and stressed its advantages in co-authoring reports of group projects, the wiki was primarily used as a publication tool at odds with its intended pedagogical affordances.

Table 3
Number of different types of artifacts and attached comments in individual portfolios

	Different types of artifacts			Comments			
	# of artifacts	M (n = 55)	SD	# of comments	M (n = 55)	SD	% of all comments (n = 314)
Blog posts	258	4.69	1.95	310	5.64	6.59	98.73%
Wiki pages	8	0.15	0.52	0	0	0	0%
Bookmarks	0	0	0	0	0	0	0%
File items	16	0.29	0.76	4	0.07	0.26	1.27%
Total	276	5.02	2.27	314	5.71	6.61	100%

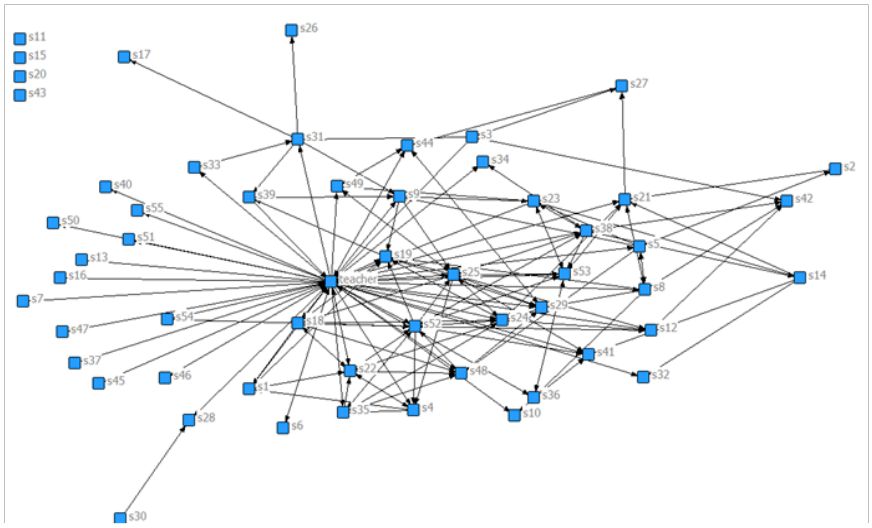

Figure 3. Social network graph of commenting activities (including comments sent to the teacher).

The initial data analysis showed that social interaction centered on assigned tasks published in individual blogs. In general, social interaction in the SNE was not active (M = 5.71, SD = 6.61) and largely short-lived. Most of the comment threads consisted of two or three comments. As the social network graph in Figure 3 shows, the teacher took a central role in social interaction. The density of social interactions was 11.98%. Only four students were completely left out of the network. However, when the teacher was excluded, the density of social interactions decreased remarkably to 9.19%. Fifteen students were isolated from peer interaction, neither receiving nor sending any comments from and to any other students. Students were knitted together in a rather loose manner (see Figure 4). On average, each student exchanged 5.02 comments with their peers (sent: SD = 6.24, received: SD = 5.58). The greater variance in the number of sent and received comments suggested that social interaction was not evenly distributed over the majority of students.

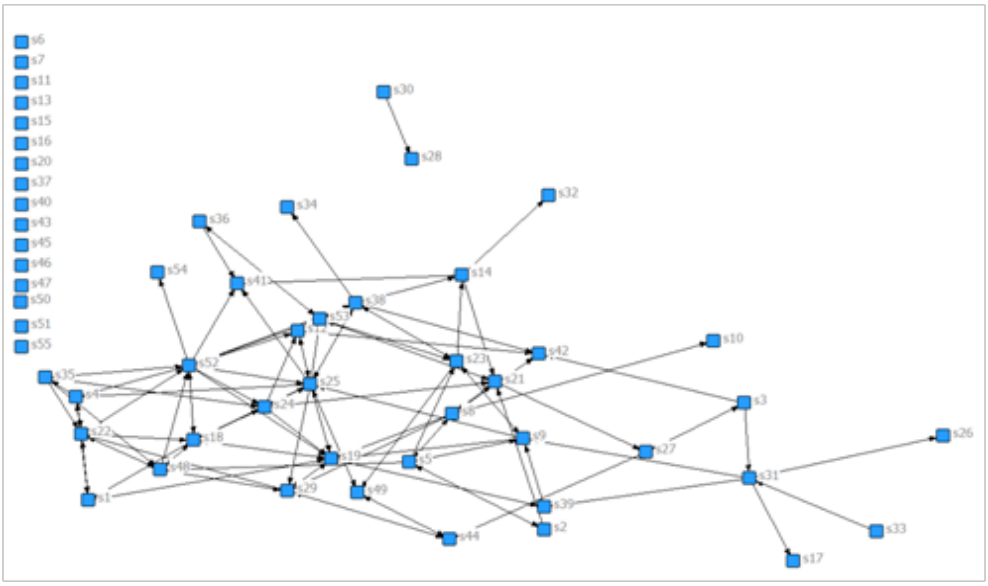

Figure 4. Social network graph of social interactions (excluding the teacher).

The Girvan-Newman algorithm was performed to reveal cohesive subgroups emerging during social interactions. Excluding isolated students and the teacher, nine cohesive subgroups were detected. The modularity score was 0.36, suggesting that the subgroups were relatively distinct (Newman & Girvan, 2004). The results indicated that social interaction in the SNE was fragmented. For example, S28 and S30, although interacting with each other, separated themselves completely from the other students.

A closer look at the constitution of emerging subgroups revealed the homogeneous nature of relational linkage (see Table 4). Eight first-year students studying in the major of Psychology (S1, S4, S18, S22, S24, S35, S48, and S52) formed a cohesive group through frequent exchange of comments. Thirteen second-year students in Software engineering (S9, S10, S11, S12, S17, S19, S26, S34, S37, S39, S41, S42, and S47) were broken into several small interaction groups, such as S27, S31, and S17 in Group 7, and S9 and S39 in Group 9. Given the fact that it was highly likely that students already knew peers studying in the same major at the same year, the results suggested that students tended to interact with peers whom they had known prior to the course. There existed other examples supporting this argument, such as between S28 and S30 in Group 4, who were third-year students majoring in Special Education and between S2 and S5 in Group 6, who were majoring in Software engineering in the first year of study.

Table 4
Cohesive groups and members

Subgroups	Members
Group 1	S1, S4, S12, S18, S19, S22, S24, S25,S29 S35, S48, S52
Group 2	S36, S41
Group 3	S14, S23, S32, S34, S38, S53
Group 4	S28,S30
Group 5	S3, S27, S42,
Group 6	S2, S5, S8, S10, S21
Group 7	S17, S26, S31, S33
Group 8	S44, S49
Group 9	S9, S39

A coding framework was developed to detect the qualitative characteristics of comments (see Table 5). In view of the scope of the study, the comments sent to the teacher were excluded from analysis. The entire comment was chosen as the unit of analysis, since a message is the most objectively identifiable unit defined by authors (Rourke, Anderson, Garrison, & Archer, 2001). Two dimensions of social interaction – cognitive and socio-emotional – were examined. Facilitating reflective thinking and exchanging emotional support are the main reasons for social interaction in the process of career development and planning (Isaacson, 1997; Pyle, 1986). Accordingly, content related to self-knowledge, occupational knowledge, and metacognition were deemed as indicators of cognitive engagement and searched for during the coding processes. In terms of socio-emotional interaction, coding categories were adapted from Rourke, Anderson, Garrison, and Archer's (1999) framework. This framework is designed to evaluate emotional aspects of communication in text-based computer conferences, making it suitable for the present study. The coding categories are presented in Table 5.

The results indicated that a total of 130 (47.10%, n = 276) comments fell into the category "cognitive". On average, each student wrote 2.36 (*SD* = 3.36) comments, manifesting different levels of thinking. It is noteworthy that no opposing perspectives were expressed in comments. On the other hand, 189 (68.48%, n = 276) comments were coded into the category, "socio-emotional". Each student contributed an average of 3.44 (*SD* = 4.32) comments falling into this category. The following two excerpts are typical examples:

Although I am a sentimental person, normally I can make good judgments based on my objectives and rational analysis. I think I should keep a distance between my private and public life or between a job and leisure time. Overall, I think that jobs like accountant, secretary, librarian, civil servant, text editor, teacher, and speech therapist (which is related to my current major), are more appropriate for me. (Cognitive)

Embarrassed, I made a stupid mistake. (Socio-emotional)

Table 5
Coding framework and results

Category	Definition	Indicator
Cognitive	Statements manifesting development of self-knowledge and occupational knowledge, knowledge of career decision-making, and metacognitive thinking to regulate learning process	• Opinions or suggestions concerning the information presented in others' posts; • Stimulated reflections upon one's experiences, interests or values with respect to career development, such as clarifying one's characteristics and engaging in metacognitive thinking in the process of career decision-making; • Metacognitive thinking about the course learning, such as reflecting on the learning process, setting learning goals and seeking help from others.
Socio-emotional	Statements that contributed to the socio-emotional structure of a learning community	• Expressing personal feelings, such as using emoticons and emotional self-disclosure; • Explicitly interacting with others, such as asking/answering questions, expressing agreement, and apologizing; • Demonstrating a sense of collective commitment for learning and trustfulness, such as disclosing vulnerability, providing suggestions, and using inclusive pronouns.

What are the factors that influence the social interaction pattern in the SNE?

Five factors emerged from the interviews and observations: perceptions of peer and teacher feedback, nature of the task, preferred collaborative strategies and learning approaches, pre-existing social relations, and the individualistic nature of the SNE.

Perceptions of peer and teacher feedback
Quite a few students believed that peer feedback was not worth the effort because it was not helpful for individual career development and planning. This was often coupled with the perception that peers' comments lacked insights:

> I don't think commenting on each others' assignment is beneficial for learning. My learning goal for reflecting on my own experience has been fulfilled once I have finished my assignments on my blogs. Besides, in my opinion, peers' comments are mostly superficial, lacking in-depth analysis. (S47)

Also, students perceived that they lacked the knowledge and expertise to contribute useful comments to their peers. As a result, some restricted their roles to those of suppliers of emotional support rather than intellectual partners in collaborative learning:

> I don't have enough knowledge to write analytical comments. The instructor's comments are far more helpful than mine because he is knowledgeable and professional. My comments were aimed to offer support to peers (S25).

Few even perceived "comment" and "judgment" as equal. For instance:

> Comments, in my opinion, are making judgments on others. It is very impolite to judge people (S17).

By contrast, the personalized feedback from the teacher was highly valued. The SNA indicated that six students communicated with the teacher exclusively on the platform. The perception that the teacher was an expert and the source of knowledge appeared prevalent:

> Although I am happy with the comments [from peers] like "Go ahead", they are not meaningful for my learning. The teacher's comments are more professional and to the point. I hope the teacher can comment on all of my tasks, giving me some professional perspectives. (S18)

Nature of the task

The nature of learning tasks to a large degree determined the amount of comments exchanged among students. The second task seemed to be more intrinsically motivated. It engaged a high proportion of students in presenting detailed descriptions of important events in their life and also evoked a greater amount of emotional, sympathetic, and reflective comments. A student stated:

> The second assignment is closer to our real-life situations and thus thought-provoking. I read many others' story since I am eager to know what the lives of people at my age are like, not only due to my curiosity, but also dissatisfaction and concerns about my current status. (S36)

The other tasks entailed more theoretical knowledge about career choice and development. Consequently, a greater amount of effort was required for interpretation and analysis. Many students merely copied and pasted test results to complete their assignments. For the same reason, they felt they did not have much to say in regards to commenting:

> The first assignment is too theoretical. It requires us to spend much time and energy to study additional learning materials. I did not even understand my test result. How can I help others interpret theirs? (S25)

Preferred collaboration strategies and learning approaches

From the researcher's observation, wikis in group spaces were only used for publishing information. The role of the group space in supporting collaboration was limited by the cooperative way of working. Simple collaborative strategies were commonly employed. When asked how the group projects were done, many responded that they divided tasks equally at the beginning, then limited their efforts to their own components, and finally synthesized different parts into whole products. Two students even worked individually so that they were able to take full control over the working process. Such collaboration strategies did not necessitate a great deal of communication and sharing after the class. This might also be the reason why co-authoring group reports never happened on wiki pages.

The pedagogical design for self-directed learning created tension as the students favored teacher-centered instructional methods. Although the participants appreciated the endeavors of the teacher to use innovative teaching and learning activities, they commented that, in their opinion, the elective course should not require students to "spend much time on assignments and self-directed learning after class". They preferred teachers to "transmit as much information as possible in lectures." Implementation of new instructional methods caused stress and confusion. This might help to explain students' lack of participation in social interaction.

Pre-existing social relations

Consistent with the findings of SNA, the interviews revealed that pre-existing social relations promoted social interactions by serving as a relational foundation. Some students were enrolled in the course with peers they had already known previously. From their point of view, social interactions mediated by the SNE helped strengthen the cohesion of pre-existing social groups:

> Through online communication, I get to know more aspects of my friends, which we never talk about face-to-face due to the feeling of sentimentality (S18).

Meanwhile, pre-existing social relations prevented some students from exploring new interaction partners:

> I don't pay much attention to the unknown students … I was more at ease communicating with students whom I knew on the platform. (S22)

The results of the SNA showed that among 15 isolated students in peer interaction (see Figure 3), four had no pre-existing social relations; seven had known only one or two peers before the class. It seemed to be more difficult for students who held no or a few pre-existing social relations to develop relatively stable interaction partnerships, or take a relatively central role, unless they were motivated to take the initiative in collaborative learning.

Individualistic nature of the SNE

It was observed that the individualistic nature of the SNE had a significant effect on social interaction. First, its distributed nature caused parallel and fragmented dialogues across the platform, which made keeping track of the information flow difficult. Second, the quality of feedback to some degree relied on the cognitive endeavors invested in the creation of artifacts that students would comment on. This echoes Dillenbourg's (1999) argument that there is a lack of disagreement and misunderstanding to arouse debate among students if the topic or content for discussion is trivial, semantically obvious, and without ambiguous terminology. That might partly explain the limited thinking induced by social interaction. The intellectual support obtained from received comments tended to be specific and insightful when students spontaneously reflected on problems they encountered. Third, the sense of ownership engendered by social networking technology encourages self-expression and emotional venting in an online learning community (Deng, 2010). Therefore, the SNE facilitated socio-emotional interaction among students to a certain degree.

Discussion

This study investigated the social interaction pattern of collaborative learning in an SNE in a Chinese university class. Firstly, the results showed that the social interaction was teacher-centered; the teacher played a central role in collaborative learning. The density of social interaction decreased remarkably when the teacher was excluded. Secondly, social interaction was found to be fragmented and distributed unevenly. Communication was reinforced within small groups rather than at a class level. Fragmented communication can hardly offer a negotiable space sufficient to reveal and resolve cognitive conflicts. Thirdly, social interaction was inclined to be more socio-emotional than cognitive. While approximately 47% of the comments showed cognitive engagement concerning career development and planning, nearly 68% were social-emotional statements. As a whole, the social interaction pattern of collaborative learning mediated by the SNE was found to be teacher-centered, short-lived, fragmented, and primarily social. Such an interaction pattern is not well in line with the two characteristics of effective collaborative learning: engaging broad participation and inducing back-and-forth discussion for solving problems. This raises an important question: can a SNA afford collaborative learning in which students are expected to develop deep understanding through continuous debate?

The results revealed five factors affecting the social interaction pattern of collaborative learning in the SNE: perceptions towards peer and teacher feedback, the nature of the task, preferred collaboration strategies and learning approaches, pre-existing social relations, and the individualistic nature of the SNE. The paper stresses three themes regarding the effective pedagogical design of collaborative learning with social networking technology. The first theme concerns epistemological beliefs about learning. Confucian-Heritage Culture (CHC) has a considerable influence on Chinese students' beliefs about knowledge and learning (Tan, 2010). CHC learners are inclined to work individually, depend on teachers, avoid conflicts, and prefer well-structured tasks (Phuong-Mai, Terlouw, & Pilot, 2005). As a result, students in this study ranked feedback from the teacher as more helpful and perceived exchange of ideas with peers as worthless for individual learning. They doubted their academic ability to provide useful comments to one another. This belief inhibited cognitive efforts and restricted social interactions to a superficial level.

The second theme concerns the effect of social relations in a particular educational context. Students often initiated social interactions with peers they already knew (Cho, Gay, Davidson, & Ingraffea, 2007). These pre-existing social relationships facilitated interaction among students who already knew each other, and at the same time, restrained them from exploring new ideas from peers of different backgrounds. This finding offers support to Cho, Lee, Stefanone, and Gay (2005), who found that students who had many pre-existing friends in a new educational context were less motivated to move around among different social circles through CMC. On the one hand, on the basis of the pre-existing social relations, students can quickly start interaction with established trust, mutual understanding, and group norms. On the other hand, if students constrain social interactions within initial existing social groups, they may lose valuable chances of accessing new ideas from peers of different backgrounds. As yet the effect of pre-existing social interaction has been less studied and mostly ignored in the process of designing collaborative learning. This study reveals this factor influencing collaborative learning and further suggests that the individual-centered style of communication in SNEs may increase the effect of pre-existing social relations on the structural characteristics of interactions.

The third theme concerns the educational affordances of the SNE. Social networking technology blends individuality and sociability, which has remarkable effects on social interaction patterns. Commenting is a major channel of direct social interaction in many SNEs. Consistent with previous studies (Hodkinson, 2007; Xie et al., 2008), it was found that social interaction through commenting activities is characterized by fragmented and short-lived conversations. Meanwhile, it is worth noting that students admitted in interviews that their deeper thinking was actually stimulated by being exposed to peers' ideas, experiences, and perspectives, although their direct social interaction did not demonstrate a great deal of cognitive effort. They valued the capability of the SNE as a learning portfolio documenting their learning process and facilitating reflective thinking. Besides, some students in interviews mentioned that they felt supported and encouraged due to emotional support received by means of commenting. It seems that, compared to the group-oriented discussion forum, the SNE could better serve as a medium for facilitating one-to-one and one-to-many socio-emotional interaction in order to foster a sense of learning community. It is suggested that the educational affordances of the SNE make it suitable to support a form of collaborative learning in which individual students are enabled to take a central role in their own learning process with convenient access to different perspectives, opinions, and learning resources, while being offered the opportunity for social interaction whenever they feel like offering support, seeking suggestion, asking for help, or sharing ideas in a learning community.

Drawing upon the findings of the study, recommendations are made for teachers to effectively use the SNE in supporting collaborative learning:

(a) Providing an assessment structure for collaborative learning to encourage active participation. The assessment structure should take into account student characteristics such as their epistemological beliefs, preferred collaboration strategies and learning approaches, and independent learning skills. For instance, assessing the quality and quantity of comments in this study could probably motivate students to invest more cognitive efforts in learning.

(b) Matching learning tasks with educational affordances of the SNE. The SNE is more suitable for supporting learning tasks that are more or less personalized in nature but can be potentially promoted in a social context. Group-oriented communication media could be offered to facilitate learning activities in which the back-and-forth discussion involving many students is expected.
(c) Paying attention to the effect of pre-existing social relations on collaborative learning. It is suggested that warm-up activities in face-to-face settings should be organized prior to online learning activities in order to help students become acquainted with unknown peers and reduce anxiety over social interaction in a one-to-one manner in the SNE. In addition, teachers could consider grouping strategies adapted to initial social relational structure of a class so as to create opportunity for students to learn from a variety of peers. Particular attention should also be given to the engagement and interaction of students who come to the class without any pre-existing social relations.
(d) Providing external regulation or assistance to students showing passive online learning behaviors, given that the individual ownership enabled by the SNE required more learning skills and autonomy on the part of the students.
(e) Designing interesting and real-world tasks to promote learning engagement.

Limitation and future research

This study used a mixed method composed of qualitative and quantitative approaches to data collection and analysis. The small sample size is noted as a main limitation for generalizing quantitative results. Further research with a larger sample size would be useful. Another limitation is that the study was conducted with a particular social networking platform in a particular learning context. Future studies could investigate the social interaction patterns of collaborative learning with different social networking platforms in various learning contexts. For example, studies could explore whether students are more inclined to engage in learning in popular SNEs (e.g., Facebook) than in less well-known ones. Important implications for research and practice can be drawn based on the findings of this study. Recommendations are generated for teachers who are interested in the educational use of the SNE to support collaborative learning. For researchers, this study may help to fill a research gap, in that few empirical studies have been conducted to explore how social interaction patterns are shaped by the SNE. In particular, by employing SNA, this study provides a social network perspective to comprehend the structural pattern of collaborative learning in the SNE. The findings may also deepen our understanding of educational affordances and constraints of the SNE.

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