

Levels and Patterns of Participation and Social Interaction in an Online Learning Community for Learning to Teach

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This study investigates how pre-service and in-service teachers participate in an online community for learning to teach. Members' levels and patterns of participation and social interaction were examined via social network analysis of activity logs and content analysis of interviews. The results of the analyses show that (a) members' levels and patterns of participation varied across time, member types, and tools; (b) members' identity and levels of participation were reciprocally associated; (c) there were similarities and differences in members' usage of computer-mediated communication (CMC) tools; (d) members showed growth in their knowledge and skills for teaching via mutual engagement, creating joint enterprise, and establishing shared repertoire supported by CMC tools; and (e) lack of time influences members' levels of participation.

INTRODUCTION

Rapid advances in ease of access and affordability of the Internet have led to expansion and enhancement of online learning in higher education. Concurrently with demographic and technological changes, researchers have been exploring alternative forms to traditional course-based learning. One such form that has potential in the field of teacher education is the use of online communities of practice (CoP). Researchers in teacher education have particular interest in CoP as a method for diminishing the gaps and disconnect between the stages of teachers' professional development. Previous studies have recognized the importance of a professional continuum of learning that spans pre-service teacher education, induction of beginning teachers, and continued professional development (e.g., Feiman-Nemser, 2001). Some cases of applying online systems to support the continuum of teachers' professional development have been found effective but not easy to sustain. (Job-Sluder & Barab, 2004; Gray & Tatar, 2004; Roup, Gal, Drayton, & Pfister, 1993; Desimone, Porter, Garet, Suk Yoon, & Birmnan, 2002). Previous studies mostly used members' login frequency and amount of messages posted on discussion boards to describe members' participation. However, these indicators were limited to present members' actual behaviors in the entire online community, including discussion in chat room, discussion board, resources sharing space, or other space provided by the community. To better understand how teachers can be supported and sustained in an online community of practice, this study investigated the participation and interaction of the online learning community via examining members' actual and overtime levels and patterns of participation in the online learning community of practice, NETwork (Nurturing Elementary Teachers' work).

COP IN SCIENCE TEACHER EDUCATION

Wenger (1998) defined CoP as groups of people who join together with a common purpose and share a common practice. Further, Wenger indicated that "Knowledge, belonging, and doing are not separable: What we know, who we are and what we do seamlessly come together in one experience of participation" (Wenger, 1996, p.22). Thus, learning and membership within CoP are intertwined. Members benefit from community membership by having a sense of belonging and having others to ask for support (Wellman & Gulia, 1999).

Since the 1990s, teachers' professional development has attempted to move beyond simply supporting teachers' knowledge and skill acquisition by changing the training format from one-shot professional development to long-term professional learning development (Vescio, Ross, & Adams, 2006). One effective approach to meeting the needs of long-term professional development is the establishment of professional learning communities (PLC) based upon a CoP framework (Wenger, 1998). A CoP framework has been identified as an effective model to support the reform of teacher practice and teaching reflection by a number of teacher education researchers (Hollins, McIntyre, DeBose, Hollins, & Towner, 2004; Andrews & Lewis, 2002; Strahan, 2003). CoP supports teachers as they integrate practice, meaning, identity, and community as components of learning and knowing in their interaction. Previous studies have found that PLC provides teachers opportunities to collaborate and supports continuous teacher learning (Berry, Johnson, & Montgomery, 2005; Phillips, 2003; Englert and Tarrant, 1995; Hollins et al., 2004). However, the professional learning communities studied were face-to-face not online. These PLC required teachers to travel to particular locations and coordinate tight schedules for meetings. Taking time to meet is problematic because teachers indicate that they do not have much time to talk or share with fellow teachers in their own buildings. Teachers' daily teaching schedules occupy most of their time (Scribner, 2003). Thus, teachers' time commitment has been a challenge for participating in PLC. Given the geographical distribution of teachers upon graduation from a university, this poses a challenge for establishing a long-term PLC across teacher education to school practice.

Taking advantage of computer-mediated communication (CMC) tools and the Internet, researchers have constructed online PLCs. Some of the most prominent online PLCs for teachers are LabNet (Roup, et al., 1993), Inquiry Learning Forum (Barab, Makinster, & Scheckler, 2004), and Tapped In (Schlager & Fusco, 2004). Barab and colleagues found first time participants to mainly be observers, but over time become contributors to the community through discussing, sharing, and creating videos of their teaching (Barab, Hay, Barnett, & Squire, 2001). Studies have shown that it is challenging and difficult to sustain members' feelings of a sense of ownership, connections, trust, commitment to the community, and a sharing culture in online systems (Barab, Makinster, & Scheckler, 2004; Schlager & Fusco, 2004). A key determinant of how teachers' long-term education can be effectively supported in an online community of practice depends on how well the social interaction can be fostered and sustained through the CMC tools, such as chat rooms and discussion boards.

A new teachers online professional learning community, NETwork (Nurturing Elementary Teachers' work), was established in 2006 using the Sakai collaborative learning environment to implement the CoP framework. The purpose of NETwork is to diminish the current distance between teacher education and school practice by providing pre-service and in-service teachers a shared, long-term environment for collaborative learning. NETwork members are expected to discuss teaching issues and share their theoretical and practical perspectives so as to expand pre- and in-service teachers' practical experiences as well as their knowledge and skills of learning theories and new teaching policies. Additionally, being able to discuss teaching issues was expected to be a growth opportunity for the practicing teachers. NETwork allows in-service teachers to discuss their practical issues and to meet knowledge and skill needs they have encountered on the job. Furthermore, the shared experience can lead to an improved community and sense of membership in a professional development community. Both pre- and in-service teachers were expected to improve practice by contributing what they experience in class or practice to the online discussion and by learning from what has been shared by others. In-service teachers not only receive feedback about their practice but serve as experienced mentors to guide pre-service teachers as they begin learning to teach. Participating in NETwork may change how members think about themselves as teachers (identity) and about how able they are to teach. These changes may occur over time and as they move from peripheral to core participation. Little is known about how to best sustain participation, the variety of ways that teachers may participate, and how sustained participation changes teachers, but the establishment of NETwork provided a test-bed for exploring participation in CoP.

SOCIAL INTERACTION OF COP

Because online PLCs operate through CMC tools and systems, how to facilitate and foster online social interaction within the CoP becomes a critical factor for the success of teachers' professional development in the online learning community (Gess-Newsome, Blocher, Clark, Menasco, & Willis, 2003). Researchers found that when people communicate or interact through online learning environments, the nature of the tools and how social constructs are established in the contexts influence members' participation and interaction (Picciano, 2002; Rovai, 2002). Hara and Kling (2000) report that communication and technical difficulties experienced by students in on-

line learning environments can frustrate them and impede interaction. This is critical because levels and types of interaction influence members' sense of community and participation (Lally & Barrett, 1999). It is difficult for members to interact and contribute in a community if the online learning environment cannot support what they expect to do. Additionally, studies have shown that without sufficient social interaction, students experience a sense of isolation even though they may appreciate the flexibility and convenience of the virtual learning space (Abrahamson, 1998; Rahm & Reed, 1998). Students' feelings of isolation were found to be a primary reason for higher dropout rates in distance education (Carr, 2000). Similarly a lack of social interaction is a factor that depresses students' satisfaction in online learning (Arbaugh, 2000). Also, students' perceptions of their interaction and sense of presence were found to have positive relationships with their perceived performance in an online environment (Picciano, 2002). Similarly, researchers discovered that teachers' interaction and participation in CoPs were associated with the effectiveness of their learning, collaboration, and how they apply what they learn (Job-Sluder & Barab, 2004; Gray & Tatar, 2004; Schlager & Fusco, 2004).

MEASUREMENT OF PARTICIPATION AND INTERACTION OF COP

According to the framework for CoP (Wenger, 1998), learning outcomes of a CoP include not only the knowledge or skills gained in the CoP but also changes of social constructs, such as sense of community, social ability, identity, levels of participation, and social relationships with others. These changes happen when members interact with others through textual communication. Textual information created or generated during members' interaction is the primary source for examining members' changes of social interaction. However, Paccagnella (1997) found limitations in studying a community only through reading the textual messages and logs. Only analyzing the textual messages ignores members' actual experiences of their participation and interaction when working in front of their computers. Also, the logs do not record the nature of turn taking that happens in chat or emails and the time of typing a reply message, which helps form the experience of collaborating in the community. Similar to Paccagnella, Mason (1999) found that in only reading the posted messages the researchers miss out on the actions that happen around the messages. In addition to only analyzing the content of messages Mason (1999) indicated that using an online survey or email interview are important methods for studying a text-based

virtual community. These findings suggest that studies, such as the current study of the NETwork community should not only analyze textual messages and activity logs but also implement survey and interview approaches in order to understand members' experiences.

Wurman (1989) identified five different methods for transforming data into information for exploring particular phenomena, including category, time, location, alphabet, and continuum. Wurman (1989) suggests that the data of studies such as this one classify data by types (e.g. survey data, interview transcripts, textual messages, and activity logs), location (e.g. activity logs or transcripts of discussion in Resources, Discussion Board, or Chat room), and time. Since the fundamentals of a community require time to develop in electronic social environments (Tu & McIsaac, 2002), a short-term observation or record of members' actions is not likely to thoroughly describe the formation of an online learning community nor represent the dynamics of a community adequately. Tu and Corry (2003) indicated that longitudinal studies are required that allow the community and participants to develop mature social learning processes. Based upon varying data types, several methods of analysis, including content analysis for textual messages and transcripts (Henri, 1992; Gunawradena, Lowe, & Anderson, 1997; Sing & Khine, 2006), frequency calculation, social network analysis, and visualization techniques for activity logs (Koku & Wellman, 2003; Gray & Tatar, 2004; Kling & Courtright, 2003) have been recommended by researchers.

RESEARCH QUESTION

The purpose of this study is to build new knowledge about how members participate in an online learning community for learning to teach. To describe the ways of participating in an online learning community, members' levels and patterns of participation and social interaction in the community were examined via multiple methods, including social network analysis and content analysis. Two research questions guided the study.

1. What are the characterizations of member activity that represent different levels of participating in the community, and to what extent did members participate?
2. What are the characterizations of member activity that represent different patterns of participating in the community? Are there differences in the patterns of participation for experienced members and new members and for pre-service and in-service teachers?

RESEARCH METHOD

RESEARCH CONTEXT AND PARTICIPANTS

An online teacher community, NETwork (Nurturing Elementary Teachers' work), has been in place using the Sakai 2.0 course management system to support K-8 science teaching since August 2006. The purpose of NETwork at the University is to overcome the current disconnect between pre-service teacher education and in-service teaching practice and to provide pre-service and in-service teachers a collaborative environment for learning to teach. The key features of NETwork include: 1) communication tools: synchronous and asynchronous tools, files sharing space, and some notification and social awareness tools (e.g. daily email digest, social presence box, etc.); and 2) learning tasks: asynchronous topic discussions, synchronous chat discussion sessions, and teaching resources or lesson plans sharing. Members of Network include: 1) professors of teacher education; 2) K-8 pre-service teachers who had started their field experience or student teaching; and 3) K-8 in-service teachers who graduated from the teacher education program of two mid-west universities. Pre-service teachers' participation started with their enrollment in one of the teaching methods courses in the teacher education program, while in-service teachers accepted one professor's invitation through out the Fall 2006 and Spring 2007 semesters. Thus, members who participated since Fall 2006 semester were classified as old members and new members are members joining in Spring 2007.

NETwork is not just a CoP within an online course. While it does integrate some activities for PNs (Pre-service Teachers/New Members) while undertaking their field experience courses, the primary goal of Network is to establish connections that go beyond the pre-service classroom in time and place. In addition to PNs, NETwork members included pre-service and in-service teachers who were not taking the teaching methods courses. Most of the NETwork activities were not necessarily related to what PNs were doing in their field experience courses. There were a total of 92 members in NETwork. Table 1 shows the number of member types of in- and pre-service teachers based on when they started participating.

Table 1
Member Types and Research Participants

Types of NETwork Members		N	Serial Interviews	Semester-end Interviews
Old Members (Since Aug. 2006)	Pre-service Teachers (PO)	38	2	2
	In-service Teachers (IO)	17	1	2
New Members (Since Jan. 2007)	Pre-service Teachers (PN)	30	2	4
	In-service Teachers (IN)	7	0	0
Total		92	5	8
Time for Participation			During Spring 2007 semester	End of the Spring 2007 semester

Note. “P”=Pre-service Teachers; “I”= In-service Teachers; “O”=Old Members since Aug. 2006; “N”=New Member during Jan. 2007

DATA COLLECTION

Table 1 shows the time schedule of the data collection and the number of members who participate in the surveys and interviews. A set of semi-structured serial interviews, semester-end interviews, and members’ activity logs recorded in the Context-aware Activity Notification System (CANS, Amelung, 2005, called CANS data below) were collected during Spring 2007 semester and analyzed to articulate members’ behaviors in NETwork. Five members who participated in serial interviews were interviewed three times throughout the semester in order to capture members’ changes in how they characterize their learning experience in NETwork. The eight members who participated in the semester-end interview were selected from members who did not participate in the serial interviews in order to collect members’ summary viewpoints of NETwork experience.

DATA ANALYSIS

Social Network Analyses (SNA via Netdraw@, Ucinet@, and Tableau@) were applied in analyzing CANS data. Especially, Tableau@ was

used to calculate descriptive statistics and construct visual representations of trajectories for characterizing levels of activities and members' levels of participation in discussion board (DB), chat room (CR), and resource sharing space (RS). The descriptive statistics and diagrams of social networks (Netdraw@) were utilized for characterizing patterns of members' social interaction and how they participate in activities.

Since this study aims to understand members' social experience in NETwork, a combination of the framework of Community of Practice (Author, 2005) and Interaction Analysis Model (IAM) developed by Gunawardena et al. (1997) were adapted to develop coding schemes of content analyses for serial interviews and for semester-end interviews. To reach inter-rater consensus, the drafts of the coding schemes were generated by the primary researcher via coding the first three interviews. Later another researcher coded the same interviews with the drafts of the coding schemes independently. The different coding results were discussed and resolved, and the coding schemes were finalized. The rest of the interviews were coded by the researchers independently and discussed to achieve consensus in the results.

RESULTS

The results generated from descriptive statistics and SNA show NETwork members' levels and patterns of participation in DB, RS, and CR, while findings from content analyses are used to triangulate the explanations of what happened in NETwork.

RESULTS OF DESCRIPTIVE STATISTICS AND SNA

The SNA results can be classified into four forms of participation, including login frequency, levels and patterns of participation in DB, RS, and CR.

Login Frequency. Table 2 presents members' login frequency from November 2006 to May 2007. NETwork, members' login frequency started relatively high in January 2007 and remained fairly consistent throughout the semester but dropped at the end of the semester.

Table 2
Average of Activity Frequency for Login (Monthly)

Included Discussion Activities	Nov 06	Dec 06	Jan 07	Feb 07	March 07	April 07	May 07
Login Frequency	n/a	n/a	102	↘ 85	↘ 69	↗ 78	↘ 43

Note. n/a represents “not applicable”; ↗ represents “increase”; ↘ represents “decrease”; → represents “no change.”

Table 3
Average of Activity Frequency for Login (Member Types)

The average is the mean number of events per day for the number of days in the month.

Included Discussion Activities	PN	PO	IN	IO
Login Frequency	292.4 (1)	14.1 (3)	9 (4)	35.3 (2)

Note. Values with in the brackets present the ranking order; 1 to 4 indicates high to low. The average is the mean number of events per member in the member type.

Table 3 and Figure 1 present members’ login frequency across member types, and Figure 2 showed the comparison of member types’ monthly login frequency. Comparing the login frequency across member types, the rank from high to low frequency was PNs, POs (Pre-service Teachers/Old Members), INs (In-service Teachers/New Members), and IOs (In-service Teachers/Old Members) across months. These tables and figures show substantial differences between login participation between pre and in-service teachers and a considerable range of participation within pre-service teachers.

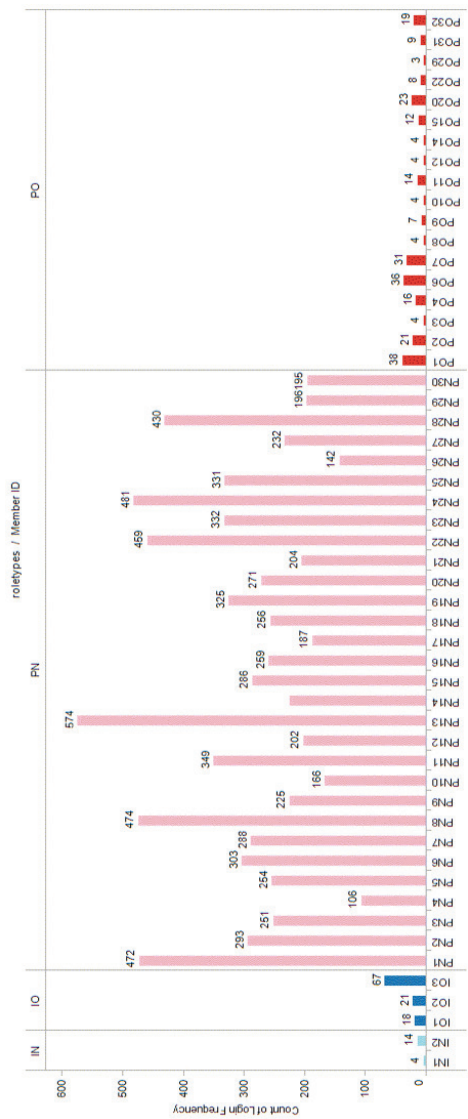


Figure 1. Comparison of Login Frequency

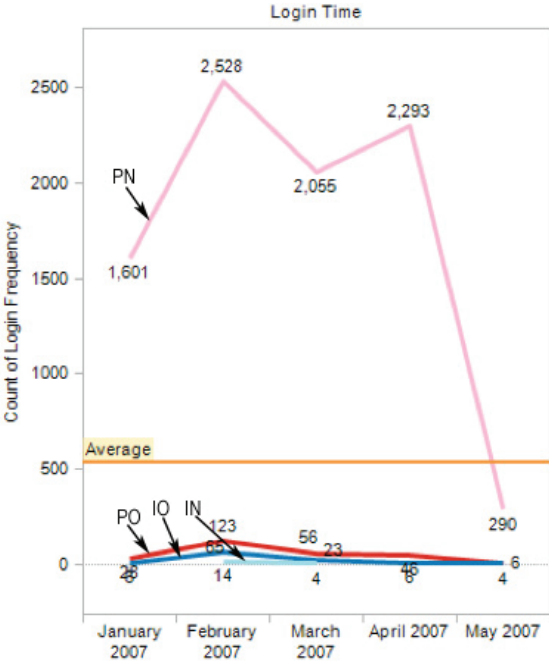


Figure 2. Monthly Trajectory of Login Frequency

Levels and Patterns of Participation in DB. As shown in Table 4, total members’ posting frequency per day increased in the second month of the semester, but later dropped in March and dropped further in April and May 2007. Similar to the tendencies shown for posting activity, members’ reading frequency increased in February and March, but dropped in April and more in May. The trajectory of members’ posting and reading activities shows the flow of participation in the NETWORK.

Table 4
Daily Average of Activity Frequency in DB

Included Discussion Activities	Nov 06	Dec 06	Jan 07	Feb 07	March 07	April 07	May 07
DB: Posting Activity	n/a	n/a	2.8	9.3 ↗	7.3 ↘	3.6 ↘	0.9 ↘
DB: Reading Activity	n/a	n/a	3.4	101.2 ↗	120.3 ↗	64.3 ↘	25.9 ↘

Note. n/a represents “not applicable”; ↗ represents “increase”; ↘ represents “decrease”; → represents “no change.” The average is the mean number of events per day for the number of days in the month.

Table 5 presents the average of each member’s participation frequency during the entire semester. The ranking of posting and reading frequency across member type remained the same. The PNs show higher posting frequency than other member types as well as reading activity. Figure 3 provides a bar chart to visualize the differences. Examining Figure 3 shows some POs only posted one or two messages but had higher reading activity. The INs’ frequency of posting activity remained zero, which indicates that INs only participated through reading messages.

Table 5
Average of Activity Frequency in DB

Included Discussion Activities	PN	PO	IN	IO
DB: Posting Activity	19.6 (1)	2.0 (3)	0 (4)	9.0 (2)
DB: Reading Activity	260.1 (1)	40.6 (3)	13.5 (4)	141.7 (2)

Note. Values with in the brackets present the ranking order; 1 to 4 indicates high to low. The average is the mean number of events per member in the member type.

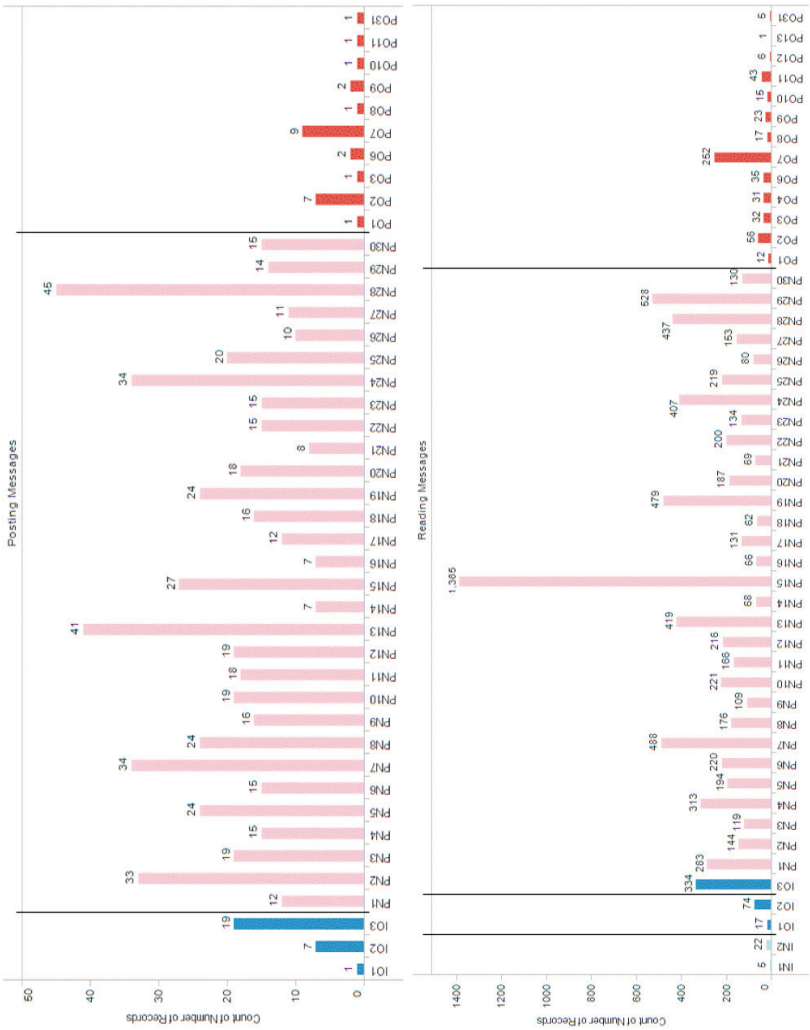


Figure 3. Comparison of Posting and Reading Frequency in DB

Figure 4 presents a more detailed view of members’ posting and reading trajectories based on member types and individual members. In addition to results shown in the Figures and Tables above, this figure visualizes the trajectories of members’ participation. For example, it specially shows that IOs only posted messages from January to March 2007, while all pre-

service teachers posted messages throughout the semester. The trajectories also indicate that members have the most posting activity in February and that the frequency of posting activity decreased gradually in the following months. The in-service teachers' posting activity stopped right before spring break (March 24th to April 1st) while pre-service teachers' posting and reading activity still carried on after the spring break. Although IOs still read messages after spring break, their level of activity was lower than before spring break. Overall, the ranking level (from high to low) of different types of members' posting activity was PN, IO, PO, and IN, and the ranking of reading activity was PN, IO, PO, and IN.

The social network diagram presented in Figure 5 and the statistical results in Appendix A and B show the relationships among members. The INs tended to read messages initiated from the lead professor (IS1) and two IOs who had the highest interaction levels with others read the messages from all member types. The PNs had most intensive interaction within their group, but most of them also read messages that originated from POs, IOs, and INs. Especially, PNs read a lot of messages posted by some particular POs and IOs who had more reading activity compared to other POs and IOs. These active POs and IOs also had more reciprocal interaction with PNs.

Some POs and INs were identified as peripheral members because they did not post or only posted a few messages but had more reading activity. These members were easily ignored by other members because their messages were rarely read by other members. Also, some POs (PO1, PO3 and PO10) did read other members' postings, but were rarely read by other members. The other case is that PO4 and PO12 read messages but never posted to the discussion that is characterized as lurking behavior in a community. Lastly, two POs (PO13 & PO31) had no interaction with other member types because they only read the messages posted by other POs.

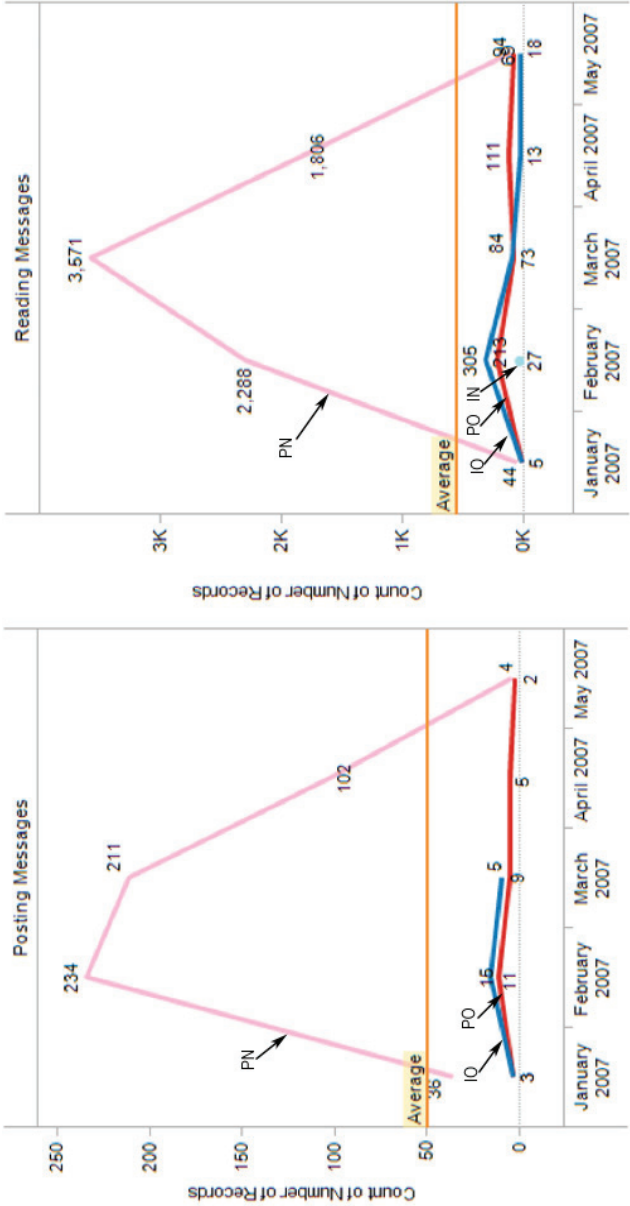


Figure 4. Monthly Trajectory of Posting & Reading Frequency in DB

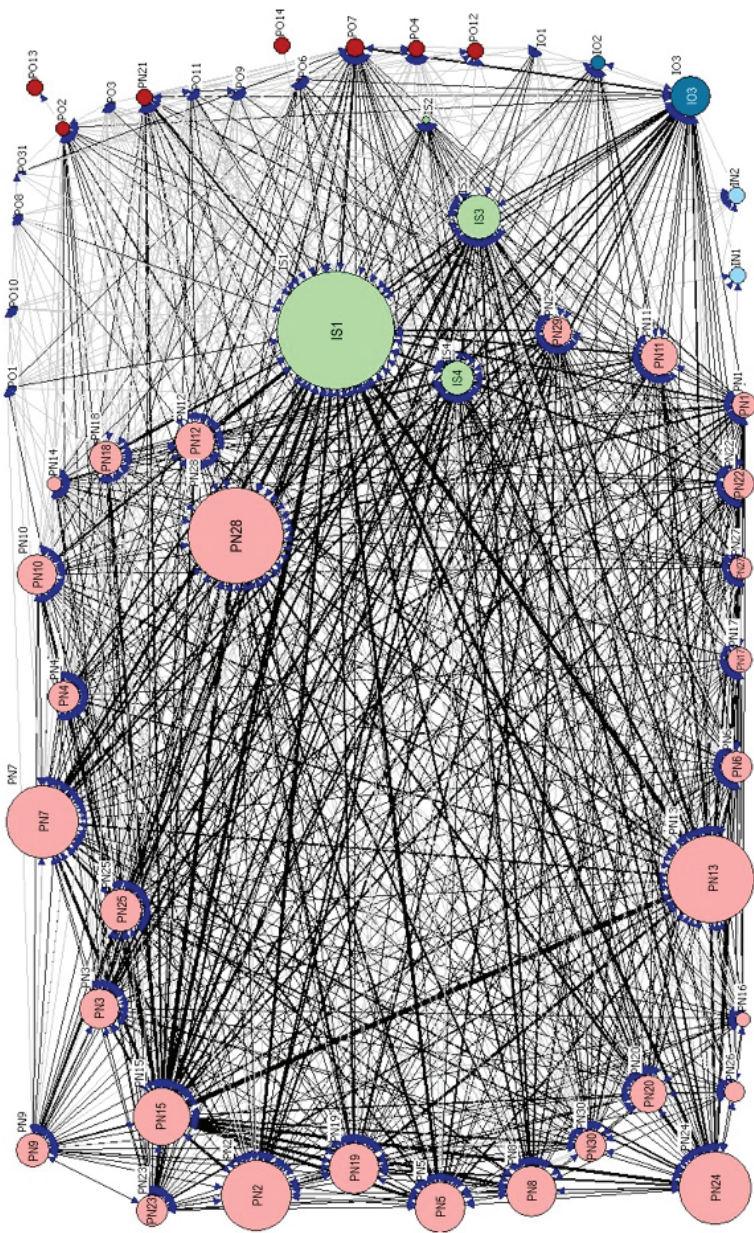


Figure 5. Interaction Patterns Diagram for Discussion Board

Appendix B presents the centrality scores and density derived from SNA. The density of the social network was 3.62 (SD=7.26), which indicates a fully dense network (network density >1). The members' out-degree (the degree to which other members read one's posts) varied between 0 and 725 (M=172.38, SD=159.04), and in-degree (the degree to which members read other members messages) was between 1 and 1234 (M=172.38, SD=203.94). The members with high out-degree and high in-degree in the NETwork discussion interaction were PN13, PN28, PN7, and PN24. Six members, including PO8, PO31, PO3, PO4, IN1, and IN2, had an out-degree less than 10, indicating that they contributed little to the discussion because few of their messages were read by others. Also, three members (PO11, PN 31, & IN1) had in-degree of less than 10 showing little reading activity and a peripheral or passive participation in the discussion. Two of these three (PO31 & IN1) members' out-degree were also equal to 0 (less than 10), meaning they were not only passive but also ignored by other members (no members read their messages).

Forty-two members were classified as information carriers because their in-degree and out-degree were larger than 0, and three members whose out-degree was equal to 0 but in-degree was larger than 0 were identified as information receivers. These three receivers included one PO (PO4) and two INs (IN1 & IN2). Overall, PNs who were the group that had higher out-degree and in-degree, showed relatively higher levels of exchanging information. Although the in-degree and out-degree were not as high as that for PNs, some POs (PO7, PO2, PO6, PO9, PO11, & PO1) and a few IOs (IO3, IO2, & IO1) also had fairly even in-degree and out-degree. These results mean that they read others' messages as well as others read their messages. IO3 and PO7 had higher out-degree and in-degree than that for some PNs. Few PNs (PN15, PN19, & PN29) had relatively higher in-degree although their out-degree were not ranked as high as their in-degree. Overall, the centralization out-degree is much lower than the in-degree (10.14%<20.96%). This shows that on a relative basis, when looking at who was reading messages, some members stood out, but that when looking at who was read (who was influential) the being read activity was more equally distributed across the members.

Levels and Patterns of Participation in RS. Overall, members had more reviewing activity and less uploading activity. As shown in Tables 6 and 7, members' reviewing activity increased in the second month of the semester (from M=13.1 per day in January to M=14.6 per day in February) and later dropped in March (M=8.0 per day). However, the reviewing activity increased again in April (M=22.1 per day) and decreased again in May 2007 (M=4.7 per day). The large reviewing activity of April probably results from

specific course requirements. April 2007 was the time period that PNs were working on the projects for the field experience courses; they, therefore, reviewed the lesson plans or other resources uploaded in Resources. Different from members' reviewing activity, members' uploading frequency was low in Spring 2007 semester.

Table 6
Average of Activity Frequency in RS

Included Discussion Activities	Nov 06	Dec 06	Jan 07	Feb 07	March 07	April 07	May 07
RS: Reviewing Activity	n/a	n/a	13.1	↗ 14.6	↘ 8.0	↗ 22.1	↘ 4.7
RS: Uploading Activity	1.06	↘ .13	↘ 0	→ 0	→ 0	↗ .16	↘ .14

Note. n/a represents "not applicable"; ↗ represents "increase"; ↘ represents "decrease"; → represents "no change." The average is the mean number of events per day for the number of days in the month.

Table 7
Average of Activity Frequency in RS

Included Discussion Activities	PN	PO	IN	IO
RS: Reviewing Activity	49.9 (1)	15.3 (2)	5 (3)	4 (4)
RS: Uploading Activity	0.2 (2)	.97 (1)	0 (3)	0 (3)

Note. Values with in the brackets present the ranking order; 1 to 4 indicates high to low. The average is the mean number of events per member in the member type.

In addition to the resources uploaded by the instructors, most resources were uploaded by POs in Nov 2006, which indicates POs shared more resources with other members in the community when finishing their field experience course. This same behavior was not repeated by the PN's in Spring 2007 semester. There were only a few PNs who uploaded resources in Spring 2007. The in-service teachers had no uploading activity. Additionally, members' frequency of reviewing resources was different across member types. The ranking level from high to low of reviewing frequency by member types was PNs, POs, INs, and IOs. In contrast to ranking level of reviewing activity, the ranking of uploading activity was PO and PN. Figures 6 provides bar chart visualizations to compare the amount of members' reviewing and uploading frequency across different member types.

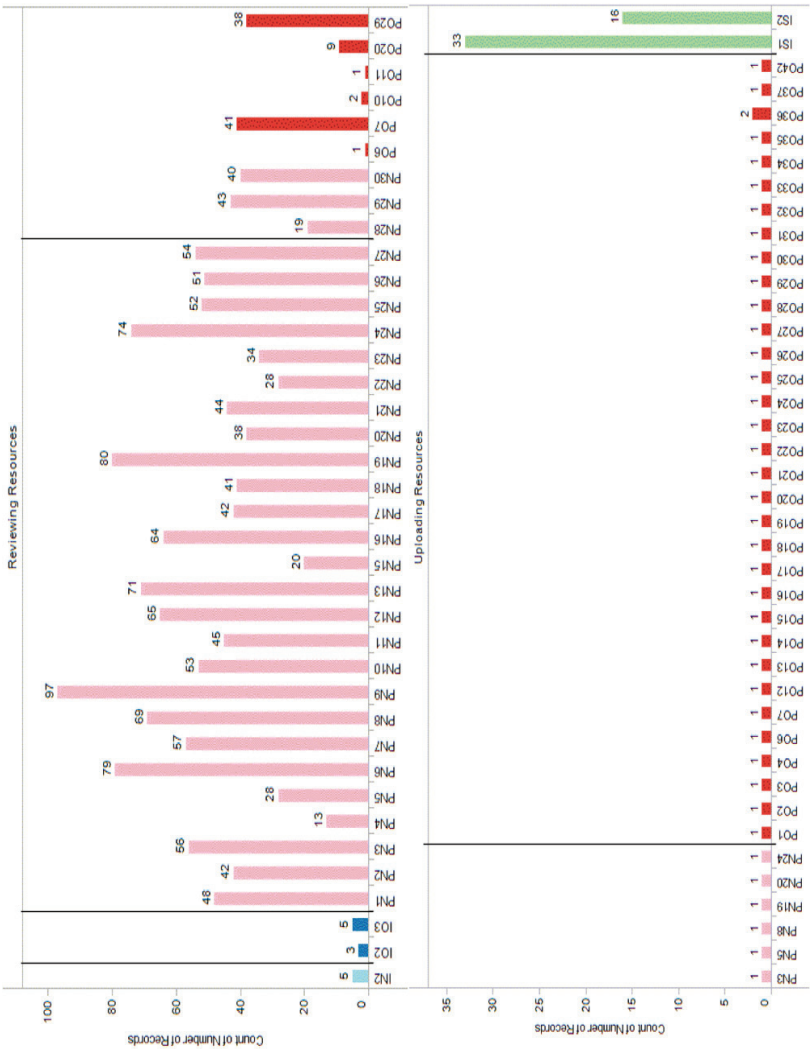


Figure 6. Comparison of Uploading and Reviewing Frequency in RS

Figure 7 presents a more detailed view of members’ posting and reading trajectories based on member types and individuals. The trajectories in the figure show when the resources were uploaded. The instructors uploaded resources through out the semester, while POs and PNs uploaded resources in particular months.

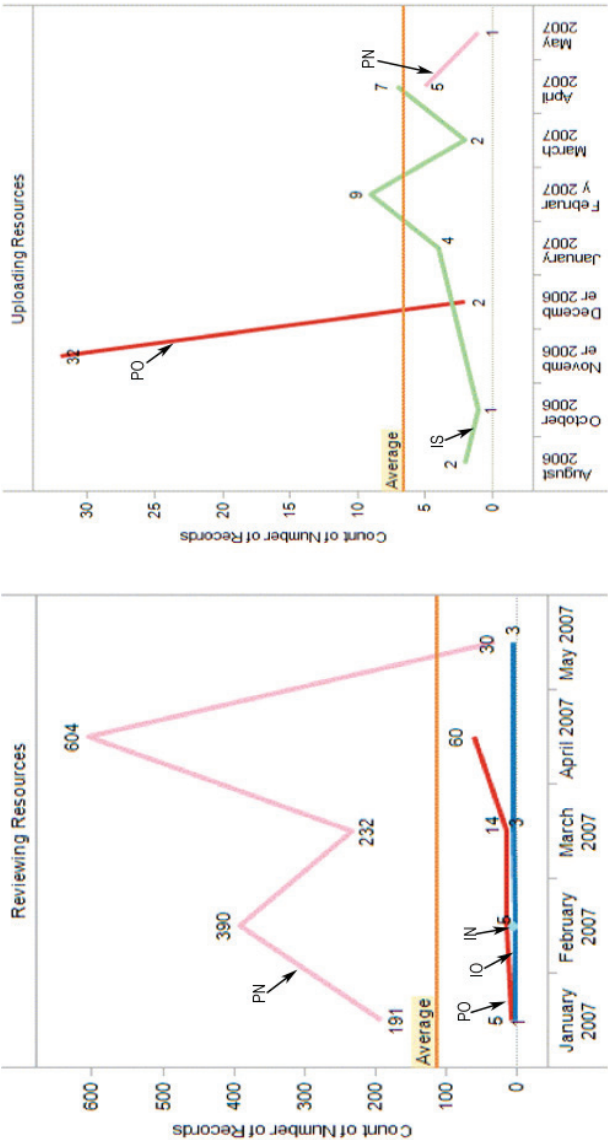


Figure 7. Monthly Trajectory of Uploading and Reviewing Frequency in RS

The social network diagram presented in Figure 8 and the statistical results in Appendix C and D show the relationships among members when reviewing and uploading resources. Refer to Appendix A for the detailed accounts of resources reviewing behavior linking reviewer and poster. The IOs tended to review both the resources uploaded by the lead professor (IS1) and other POs, but INs only reviewed resources uploaded by the POs (i.e. PO3, PO28, PO29, PO32, PO35, & PO42). Different from other PO members, PO29 reviewed resources uploaded by the instructors while other POs reviewed only some resources uploaded by other PO members. Additionally, PNs reviewed the IS2's resources more than the lead professor's, which indicates that IS2 was likely uploading resources relating to the course work of PNs and the lead professor mostly uploaded resources without specific course purposes. Compared to members' activity in DB, members had less interaction with each others in RS and the patterns of pre-service teacher's interaction were varied.

As shown in Appendix D, the density of the social network was .10 ($SD=.47$) which indicates a sparsely-knit network (network density close to 0) that implies a low proximity among members. The members' out-degree (the degree to which other members reviewed one's resources) varied between 0 and 28 ($M=5.97$, $SD=6.91$), and in-degree (the degree to which the member reviewed other members resources) was between 0 and 43 ($M=5.97$, $SD=10.25$). Because the POs were invited to upload their lesson plans in the end of the Fall 2007 semester, they have higher out-degree scores than all the PNs and INs. Those lesson plans from the PO's were used in the Spring by the PNs while they were working on the same projects. Because most of the resources were from ISs and POs, both the instructors and POs were the primary contributors to the shared resources.

Additionally, because POs were not taking the same field experience courses, they did not need to review these lesson plan examples because the subjects for their field experience courses in Spring 2007 semester were different. Thus, POs had higher out-degree but lower in-degree because they were the resource providers and did not review these resources during Spring 2007 semester. For most of PNs and in-service teachers, they did not upload resources to share with others. Their out-degree scores were equal to 0. Only five PNs (PN8, PN20, PN24, PN19, & PN3) uploaded resources to share with others in Spring 2007 semester. The most active members in reviewing the resources were PN19, PN3, and PO7 as shown by their high in-degree score, indicating that they reviewed many resources submitted by others. Further, the out-degree of the centralization is lower than the in-degree of the centralization ($4.83\% < 8.12\%$), which shows that the group that

received information (who reviewed resources) is more centralized than the group of members who had resources reviewed.

In Figure 8 the size of nodes represents the amount of resources uploaded by a member and the linking lines (ties) represent members' reviewing activity. The node sizes among the members who uploaded the resources are fairly even because most of them uploaded only 1 resource. The instructors have bigger nodes because they were the primary people to upload resources. Members who reviewed resources but did not upload any were represented with a small circle. Leaving out reciprocal relationships between the instructors and members, the only reciprocal relationships exist between PO7 and PN3 and between PO7 and PN19 (black lines). The rest of the relationships were one-way relationships (gray lines).

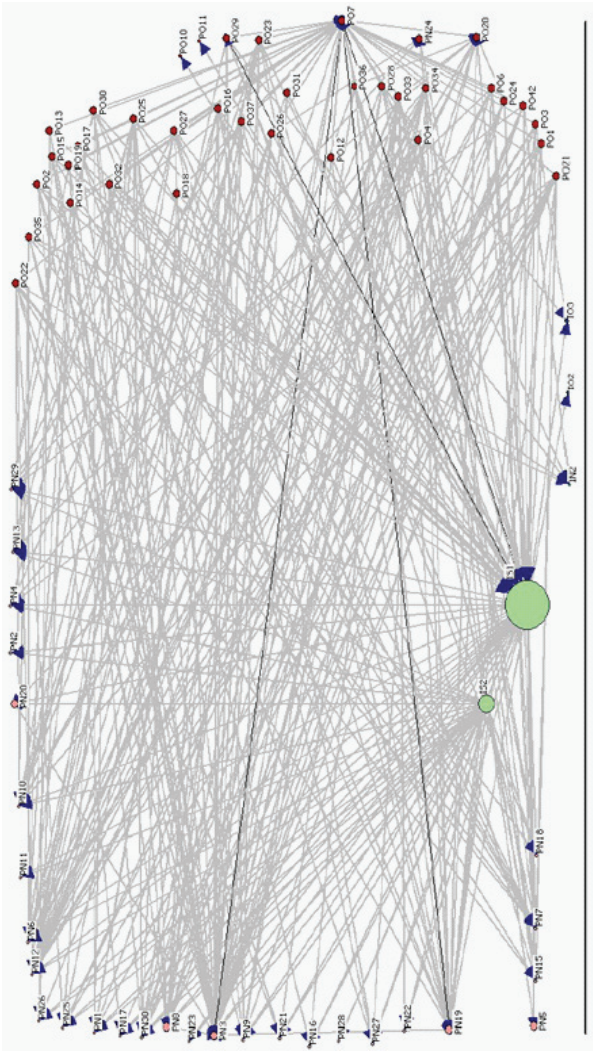


Figure 8. Interaction Patterns Diagram for Resources Sharing Space

By examining the directions of information flow, many one-way direction arrow lines were from POs to PNs and in-service teachers. Especially, PN3, PN8, PN12, and PN19 were the PNs who had high levels of reviewing activity. Except for PN19, who reviewed many IS2’s resources, the informa-

tion reviewed by PN3, PN8, and PN12 were from POs. Additionally, PNs reviewed more resources uploaded by the instructors, but the instructors did not review PNs’ resources. Also, a difference between the two instructors’ (IS1 & IS2) interaction patterns is half of the lines linked to the lead professor (IS1) represent her reviewing POs’ resources and another half represent her resources being reviewed by POs, and IS2’s resources were all reviewed by PNs. The activity in the resource sharing area shows that tasks requirements can have a substantial impact on participation. The results show that even when the task requirements (pre-service teachers needing to develop lesson plans) are the same across a type of membership there may be substantial diversity in the way members act to meet those requirements.

Levels and Patterns of Participation in CR. Members’ overall chatting frequency was higher during the time periods when discussion topics were scheduled. Chatting frequency increased in February, and dropped gradually in March, April, and May (Table 8 & 9). Compared to the arranged discussion topics, members’ ad hoc chatting activity contained more social information to ask for help or suggestions. Members participating in discussion topics mostly started their conversation with some socialization sentences and then moved to the discussion topics.

Table 8
Average of Activity Frequency in CR.

Included Discussion Activities	Nov 06	Dec 06	Jan 07	Feb 07	March 07	April 07	May 07
CR Chatting Frequency	n/a	n/a	3.8	↗ 4.0	↘ 1.5	↘ 0.2	↘ 0

Note. n/a represents “not applicable”; ↗ represents “increase”; ↘ represents “decrease”; → represents “no change.” The average is the mean number of events per day for the number of days in the month.

Table 9
Average of Activity Frequency for CR

Included Discussion Activities	PN	PO	IN	IO
CR Chatting Frequency	7.2 (2)	26 (1)	0 (4)	1 (3)

Note. Values with in the brackets present the ranking order; 1 to 4 indicates high to low. The average is the mean number of events per member in the member type.

Figures 9 and 10 provide visualizations to compare members’ chatting frequency across different member types and time periods. The total number of messages posted by the PNs was more than messages posted from the POs and in-service teachers. In-service teachers were found to have less participation in CR throughout the semester, and only one of the POs participated in the first official topic discussion. In January 2007, 19 out of 31 PNs, 1 PO, and 1 IO participated in the CR activities even though there was no official chat discussion topic. In addition it can be seen that the primary professor (IS1) and PN20 engaged in substantial chat in February. Members’ chatting activity was more active on the days chat room topic discussions were scheduled. Compared to members’ participation in DB and RS, members had a lower level of participation in CR.

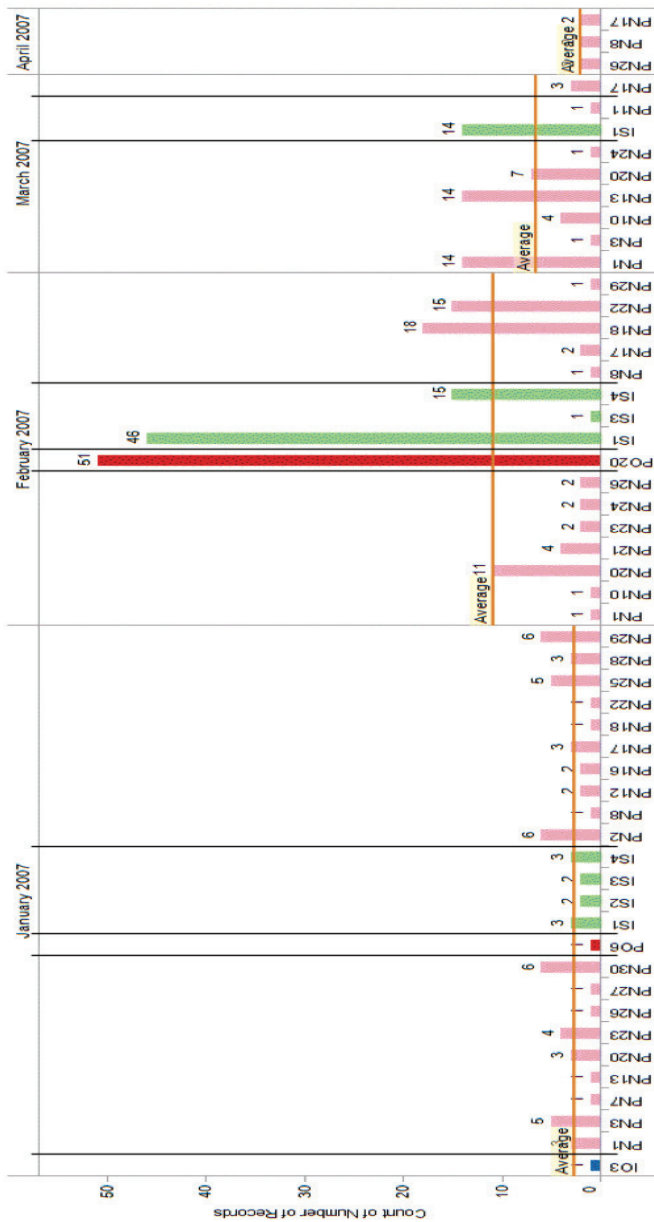


Figure 9. Comparison of chatting Frequency in Chat Room

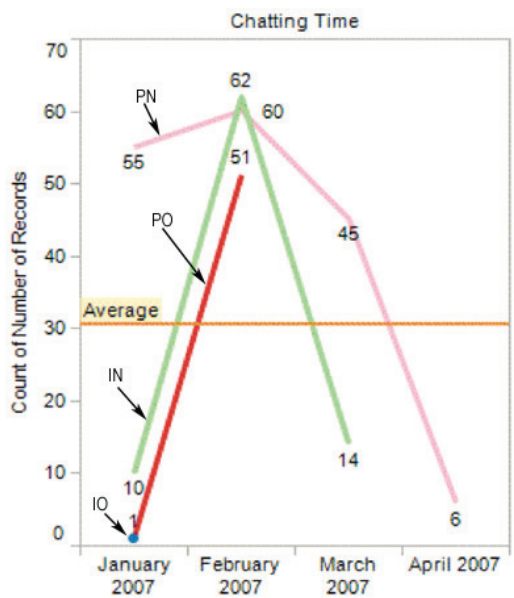


Figure 10. Monthly Trajectory of Chatting in CR

RESULTS OF CONTENT ANALYSIS

The results of content analyses include two forms of data: analysis for serial interviews and semester-end interviews.

Content Analysis of Serial Interview. The purpose of the content analysis for members’ serial and semester-end interview transcripts was to examine members’ perceptions of participating in NETwork and interacting with others. Four insights are notable from the content analysis of serial interviews. First, the participation patterns of the in-service teacher (i.e. IO2) who participated in the serial interviews changed over the course of the semester in a positive way. At the beginning of the semester, she stated that it was beneficial to see different members’ perspectives and see their questions about teaching and about getting ideas for the ways to teach different topics and students. In the middle of the semester, she did not believe that the way she taught in school was influenced by what she saw in NETwork; however, at the end of the semester, she described an experience of applying what she gained from NETwork discussion to help her students. She started the

semester feeling that she was not getting much from other members' perspectives but ended up adopting some of what was discussed in NETwork to her current teaching in school. Also, IO2's sense of community changed through the semester. She originally felt that she was not necessary as a part of the group in NETwork, but more like a helper to provide suggestions to their questions and concerns. In the last interview, she expressed how she came to know more about other members by reading through their postings during the semester, but not necessarily getting closer with other members.

IO2: "I think I get something out of it, because it's useful to read different ideas and tips and just even though they're pre-service teachers it's still good to hear a discussion to see things and think about things that make you think about things and how I'm doing things in my classroom, too."

"when I read through them, they're students, so I read a lot of things that they said that I remember saying when I was in school. Like questions and concerns and things like that. So I don't really feel part of their group, I just feel like I'm kind of a helper.....When you read something that they (other members) wrote, it's kind of tells you what they're like..... like I could get on if I had a question to ask. I don't think I've necessarily gotten a lot closer, but I think I've always felt comfortable."

The second insight is that the attitudes of PNs about participating in NETwork changed through the semester. The PNs described NETwork as an irritation for most pre-service teachers at the beginning of semester. However, their perceptions changed positively through the semester. By the end of semester, the pre-service teachers saw the value of participating in NETwork and thought that NETwork would be very helpful for their student teaching because they would be able to discuss more about the actual teaching practices. Below is an example of how one of the PNs described how she felt.

PN13: "I think that it's just gotten better over the semester because, at the beginning, I know people in my class were just irritated because it was one more thing we had to do and the other blocks were doing it... But now it's almost become just like checking your e-mail. You just get on, you see what people are talking about, you throw in your input where you think you have input and at the end of the semester, we're going to have a bunch of—and obviously, you can keep

getting back in it—so we're just going to have a bunch of resources that we can keep going back to, which is good because I take notes in class, but I don't write down exactly what people are saying. But on here, you can get on, you can actually see exactly what people were saying. So I think it's nice.....overall... I think that it's put together really well. You get on there and you can navigate around really well and so I think it's a good, good site."

Third, for the two POs who participated in the serial interviews, their levels of participation started and remained relatively low (logging in about once or twice per week) and primarily consisted of reading activities. For example, PO6 said that she could exchange ideas with other members last semester, but not this semester because she did not know most of PNs. However, their feelings about participating in NETwork were different from the previous semester (Fall 2006) when they were required to participate in some discussion forums. In the Spring 2007 semester, they stated that since participation in NETwork became voluntary, they found it to be more meaningful to them. However, participating in NETwork also became lower priority because of their busy schedule once it was not required. Below is one sample statement from PO6.

PO6: "I wasn't as active as I was last semester. Because I don't really know any of the students who are on Sakai right now. So I feel like last semester we could exchange ideas because we were in the same classes. But I really don't know anybody.....Well, I think it's more meaningful this semester just because it's an option. It's not a requirement for me to do this. And just having that connection of this is going to help us in real life and we see examples of teachers across the country participating."

The fourth insight is that members saw specific advantages of DB, CR, and RS. Especially, pre-service teachers felt DB provided them not only opportunities to discuss teaching issues and access to different points of view but also an opportunity to ask questions. Below is an example of how one of the PNs described it.

PN13: "I think it's more just when we have to post on the discussion board it's a lot more like responding ... Like, if you go in there and read it, it's a lot more like responding to other people. Because there'll be an original question and

then people answer it, but it's almost like people start answering other people's instead of going back to the original question, answering that. So it's kind of cool because it's actually like a classroom discussion, where you build off each other."

PNs felt better when they did not have required postings after spring break. When they did not need to worry about how many required messages they needed to post, they started looking for posts that they found interesting and felt passionate about. Below is an example of how one of the PNs felt.

PN13: "I think in class, especially after spring break, because everyone's just ready to be done with school, that I think a lot of people come to class and they have their laptops or they're kind of working on whatever they want to work at rather than being engaged in conversation. But when you go on here... I know that when I get on the discussion board... Er, yeah, in the discussion boards, I actually look for things that I could have input on instead of just posting on the first one I come to, you know? And so it's nice to have a discussion with someone who's maybe passionate about the topic or actually has opinions about the topic instead of just talking about things that the teachers want us to talk about."

The pre-service teachers also stated that they were soon to do student teaching, and some ND Topics, such as "The First Year of Teaching," "Classroom Management," "Tips and Advice," "What should a teacher do?" provided direct help and caught their attention, which can at least partially explain why the total amount of messages in these discussion forums are higher than others.

Additionally, CR was one of the tools that members liked most about NETwork. The members indicated that at the beginning of the semester, PNs were chatting all the time. However, after a few weeks, the participation level of chat room faded out because members' moved their focus to discussion board discussions. Below are how PN13 and PO4 described their experience.

PN13: "I like the chat room...It's kind of funny ...Because we get on and there'll be two of us on, because it gives a little symbol next to their name if they're in the chat room.

And so we'll talk. But when we first got it, it was like we were chatting all the time. But now it's kind of faded out. But I like ... There's one part in it for field, the discussion board, where we just give each other fun ideas for lessons and activities, and I think that's cool.....I think that the chat aspect is really good as far as the live chats we do. But the chat room in general is just very hot and cold. Because some days you'll get on there and people are chatting, chatting, chatting. And then some days someone will ask a question but it will go unanswered for days because no one's even checking the chat room..."

PO4: "I really like the Internet chat, or the online discussion. Because I feel like with postings, like you'll get your answer in a few days or so, but like with the chat discussion you get an answer right away. Like, for instance with yesterday, with the student teaching, if you had a question, you got an answer right away. And I like the postings and everything, too, because you can see the interaction between the students and everything, but I think the chat discussion is my favorite part. Because you can get an answer right away. Like, if you're really concerned about something, they'll just get you that answer. I think that's the"

The shared resources, especially the lesson plans, in RS were identified as a benefit by members. For PNs, they felt reviewing others' lesson plans helped them gain ideas and start their own lesson plan. For POs who were taking different field experience courses (different subjects) in Spring 2007, they did not use the lesson plans very much because they were developing lesson plans for different subjects, such as art and music. Below is one sample comment from PN25.

PN25: "it was nice to see the variety of topics. I will admit that. Because that's how they were documented, or saved, I guess, on Sakai. And so it was nice to see water cycle, magnets, and electricity. So it was good to see that. That was helpful."

Content Analysis of Semester-end Interview. Six insights were found in the content analysis of semester-end interviews. First, members perceived the information provided from different types of members differently and

constructed an identity and role for themselves that related to their position in the community. In-service teachers who were invited by IS1 to participate in NETwork knew that they had more practical experience than the pre-service teachers in NETwork; thus, they perceived themselves as helpers to provide practical suggestions for their questions. These in-service teachers also identified being able to access to resources, ideas, stories, and examples of teaching as the critical value of participating in NETwork. For example, IO1 expressed how he felt below.

IO1: "...So many of the questions posed or discussions have to do with people who are inexperienced. More my role is coming from an experienced teacher and giving them advice or helping them in terms of, "Hey, this is my situation, it may be different because every class is different. But this may be able to help you." And in terms of other strategies, just opening my eyes to different resources and that sort of thing. That was good."

For pre-service teachers, they perceived the in-service teachers as a group who could provide special insights for in-school experience to help clarify what really works in current educational environments. Thus, pre-service teachers expressed the high value they perceived in gaining practical perspectives from in-service teachers. Below is how PN20 expressed how they felt.

PN20: "Yeah, well with the in-service teachers' postings, it was kind of refreshing to read those because those are actually people who are in the field right now. And so a lot of my classmates, we have opinions, but it's nice to either hear someone who's actually in the field saying something different, or you know, agreeing with us. "Yes, this does happen; this is important." And with the professors, they were kind of the same... like the in-service teachers and could actually give you advice on real life experiences..... I mean, all of our classmates, we write about things that we might predict will happen or that we don't think will ever happen, but then when we hear these in-service teachers, they can actually give us examples.....the professor can go back and forth from being the in-service teacher to being with us students, you know? So they're kind of middle ground."

Although pre-service teachers knew that they could gain practical and valuable lessons from in-service teachers, some PNs also expressed that they were intimidated when interacting with other members who they did not know, especially in-service teachers. The pre-service teachers were uncertain about how the in-service teachers would react to their questions. That is the reason why some of PNs indicated they preferred to read the messages from someone who they knew. Below is how PN28 expressed their feeling.

PN28: "I'm one of those people that when I read something I like to picture that person. Because it kind of adds to it. You know how they talk. You know how they'd say it. And you know their mannerisms. You know if they're being sarcastic or not. But when you don't know them and you're reading their posts, you just kind of take it for what it is...I much prefer to read my peers' stuff, just because you can add character to it when you're reading it. If it's just somebody you don't know, for all you know it could be someone—I mean, it's obviously not some random person off the street posting, because the access is limited, but at the same time, where did they come from? Do they know how much you're going through?"

Further, members also perceived the information from the professors and other members differently. They liked to review the messages posted by the professors because they knew that they were knowledgeable people about teaching. For example, PN27 expressed his feeling below.

PN27: "Well on the discussion forums, I kind of like when IS2 posted, my math professor. And when Dr. IS1 would post, I'd tend to look at those because they're usually not very opinionated and they're a lot more open, kind of just for a response from students. So I like to look at those. And then, on the live chat, I talked with a couple of the teachers that I ..., but besides that, I haven't really replied to very many of them."

The second insight is that pre-service teachers who were taking field experience courses saw differences in the voluntary and required discussion in NETwork. PNs indicated the critical difference between the NETwork Discussion Topics (voluntary) and the Mathematics Extended Class Discussion Topics (required) was that in the general Network discussion they had

opportunities to interact with other members who were outside of their field experience courses (i.e. in-service teachers) but not in the Mathematics Extended Class Discussion Topics. Also, they felt the ND Topics were much more interesting than the Mathematics Extended Class Discussion Topics while the latter was graded as part of their course participation and the former addressed more practical issues. Below are examples of the pre-service teachers' perspectives.

PN27: "well I think that this first top part, the NETwork discussion forums, were even more beneficial because those were people who were other than the people in my class. Like for example, in the math discussions, it was just my classmates who I talk to outside of class anyway. But the NETwork discussion forums had people—first year teachers, and people teaching now, and I thought that was really helpful to hear what they had to say about certain things that I use, as pre-service teachers don't know about and can't contribute to the discussion."

PO2: "When it is required to post something in the NETwork, I kind of login more to check if anything there that I need to post or discuss. But after it becomes a voluntary thing, I kind of join in the discussions with my own will. I did not check it everyday, but I check it one a while to see if there is anything there that is related to my teaching and what I am doing in class now. It is different when it is required and when it is voluntary."

Third, when participating in NETwork discussion, members decided to participate in discussion topics based on their interests. When the topics were about something that they cared about and found more interesting, they participated more. Members liked to participate in fresh topics instead of the older topics in which not many people were responding, because they thought other members rarely reviewed or replied in the older discussion topics. Below is an example from PN16.

PN16: "So I look at the topic line and if it says something, then I'm like, "Yeah, I could probably have something to say." And then I try and skim through everybody else's posts. And then reply to that. And I look at the date. I mean, if it was two months ago, I'm not going to post again on it... recent is usually what I do. Although it wouldn't matter if I

went to an older one, I think I've posted on a lot of the older ones, so I try and do recent ones instead."

Fourth, members also identified some advantages of NETwork tools, including DB, CR, and RS. Members described that the format of DB discussion made the discussion more focused compared to traditional face-to-face discussions. To give an example, PN28 expressed how he felt in the following passage.

PN28: ...when you post something you can't take it back. So that's kind of cool, too. If someone wanted to say something, like in a conversation they can, a lot of people like to dance around. But in a post you kind of have to stick to the point. Just because if you go on, no one's going to read all that. So I think the NETwork kind of forces you to stick to the point... It's more focused... And so that's what I liked... like if I'm in a conversation with someone and they don't agree with me, sometimes they get defensive and they might turn it into... not an argument but more of a debate... when we talked about diversity in the classroom, there were a lot of people who get very into it. They're very loud and they think they're right, so they don't listen to anybody else. Well, in here you kind of have to—even though you don't want to read on—you kind of have to read some of their, what they had to say. And you can't interrupt them because it's already posted. And it kind of forces you to narrow your statements, because you can't go on and on be like, "Well, I think this and I think that." It's kind of going to be like, "Well, this is what I've found. This is what I've done." You kind of take "you" out of it. So that's what I like."

Members described that via chatting in CR with other members, such as in-service teacher, who they would not meet face-to-face they came to have a sense of who they are and felt more comfortable to ask them questions via the private message tool. Especially, the display of users' names in the CR helped members gain a sense of others' presence as a person. For example, PO2 expressed how they felt about it below.

PO2: "I feel more comfortable to ask questions or send private messages to the in-service teachers who I have conversation with in the Chat. In this way, it won't be wired to suddenly send them the questions. I feel that after the chat discussion, it kind of help me built up the connection with them."

Also, members stated that they felt supported by NETwork, and one of the reasons was that information and resources shared in NETwork were very helpful for developing lesson plans. Members gained benefits from having a shared repertoire that was supported via Resources. Below is one statement from PO2.

PO2: “the teaching support that I have from my professors, such as IS1 and the NETwork are very good. I feel that I have been supported by them. The information and resources are very helpful for developing my lesson plans, as well as the discussion provide different perspectives of teaching.... the examples of the Resources provided me ideas to start with my own lesson plans. Also, connecting with my friend who can review my lesson plans help me a lot.”

Compared to information found on the Internet, members stated that the resources shared in NETwork by the professors and other members were more reliable. A comment from PN27 illustrates this point.

PN27 said: “...this is good because some resources, if you’re just Googling, are really unreliable. And I feel like this (NETwork) is a good place to come for reliable information and resources.”

A fifth insight is that PNs felt confusion and annoyance about using NETwork as part of their course work. They felt that NETwork was just one more thing that added to what they needed to do for the field experience courses. However, after participating for a few weeks, they started seeing the value of it and preferred to have it as one of the resources they could have in the future. Below is how PN20 described her reaction.

PN20: “I mean, at the beginning of the semester it was hard to get used to it. And I think some of my professors were confused because they hadn’t really worked with it, either. But after the first week, it was pretty easy to get used to.”

Lastly, members expressed that a shortage of time has been an issue for their participation of NETwork. The in-service teachers indicated that heavy working loads in their first few years of teaching influenced their participation. Similarly, POs described that heavy working loads for their courses during the semester prevented their participation when they did not use NETwork as part of their courses. They felt they did not have time for participating in NETwork when they were getting busy with their other work.

Also, some PNs explained that the required postings (i.e. 5 postings/weekly) requested from the Mathematics Extended Discussion Board Topics occupied most of their time and kept them from participating in other NETwork Discussion Topics which were voluntary. Below are stories from in-service teachers and pre-service teachers.

IO15: “well, first off, I’ve actually only logged on a couple times. I would honestly say only a handful of times onto the NETwork. And that’s just due to... it is my first year of teaching and I’ve been extremely busy.”

PN27: “I really, really liked just being able to share ideas and read what everyone else had to say about certain things. The only thing I really didn’t like... is that, for some of our classes, we would be required to have a certain number of posts, so it seems like it was almost more to meet the requirement than to actually put thought into something. And I think, more so, I will use the NETwork more when I’m not doing it so much for a class, but to talk with other teachers and stuff during my first years of teaching.”

DISCUSSION

Similar to what was found in prior studies (Fusco, 2002; Kling & Courtright, 2003) examining members’ levels of participation in teacher online learning communities (Tapped In & ILF), time is a variable related to members’ levels of participation. While Kling and Courtright (2003) examined members’ participation across a longer time period, such as 9 months, 1 year, or 3.5 years, than the present study, the present study provided detailed monthly trajectories of more forms of members’ participation. These trajectories provide a picture for comparing members’ changes in participation across time and member types simultaneously. The results show members’ participation levels varied across communication tools. Although prior studies used time as a variable to examine changes in the levels and patterns of participation, the forms of examination were limited to only login frequency and number of messages posted. Fusco (2002) employed members’ login frequency as a way to assess members’ levels of participation, and Kling and Courtright (2003) used both login frequency and members’ numbers of messages posted to describe members’ levels of engagement and participation. Going beyond prior research (Gray & Tatar, 2004; Fusco, 2002; Kling

& Courtright, 2003), the present study utilized multiple indicators, including members' posting and reading activity in DB, chatting activity in CR, resources reviewing and uploading activity in RS, to show a broad range of behaviors for interacting and participating in activities via these tools. Additionally, Fusco (2002) and Kling and Courtright (2003) addressed members' patterns of participation by presenting the average of members' login frequency during a particular time period, which was limited to providing the overall change of a group of members' participation by logging-in or posting messages. This study employed social network diagrams and statistical indices to present members' patterns of participation across member types and communication tools.

According to Preece (2000) and Wenger (1998), members in an on-line learning community are governed by policies and norms generated and practices undertaken in the community. The findings reported above support this premise by showing that participation was shaped by task requirements, expectations, roles and events of the community. Members' levels of participation varied across member types and were influenced by the requirements of the field experience courses, how the discussion activities were arranged, how others participated in the discussion, and how members socially interacted with each other. Additionally, Lave and Wenger (1991) indicated that activities, which are inherently social and shaped by the context, influence one's sense of identity, how and what is learned, and the meaning of practice. The way members interacted with each other and how they perceived social constructs in online learning and what they have learned in NETWORK supports Lave and Wenger (1991) assertion. For example, PNs interacted with some particularly active POs and in-service teachers. Their understanding of practical teaching and teaching science was shaped not only by the courses they were in but also via conversation with teachers who had practical experiences. PNs were found to have more interaction and had a higher sense of community within the PNs group than with the other role groups. They explained in the interviews that it was because that they were taking courses together and frequently met during the semester. Also, members' varying levels of participation can be explained by the practices and their roles in the community, which lead to different levels of participation and different perceptions of their identities as well. For example, the POs and IOs who had the most reading activity, had more reciprocal interaction with PNs. Some POs who were less active, did have substantial reading activity within the PO group. Some POs and INs who had little posting activity but more reading activity were identified as peripheral members, and these members were relatively ignored by other members in the community.

Wenger (1998) indicated that members' identities are formed via participation and non-participation (i.e. being an outsider or peripheral and marginalized participant). The present study found that members' levels of participation and the way they perceived their role in the community were reciprocal. Members' perceptions of their identities in the community were shaped through discussions with others, learning from diverse perspectives about practical teaching, and associating with others during community events. The PNs, POs, and in-service teachers perceived their role and NETwork as a community differently. PNs started with an attitude that participating in NETwork was annoying because they felt the required participation was something extra added to their original course work load. However, this attitude changed after participating in some voluntary discussion in NETwork because they learned that the discussion topics were relevant to their immediate and practical concerns they had for future teaching. They found value in having interactions with members with practical teaching experience. Also, the in-service teachers saw themselves as a helper to share practical teaching experience with pre-service teachers at the beginning of the semester; however, as they participated in the discussion and interacted with other members, they found that they gained ideas from the multiple insights of members (including pre-service teachers and other in-service teachers) about teaching. They even found that they applied some of what they read about in the discussions to their in-school teaching.

Further, Kling and Courtright (2003) found that members, including pre- and in-service teachers, in ILF did not show the levels of engagement and critical reflection expected. They described how members' discussion primarily consisted of questions or opinions that were irrelevant to discussing planned video topics. However, the present study found that NETwork members who participated in DB and CR topic discussions were engaged and focused on the arranged topics by sharing their experiences and suggestions. Differing from Kling and Courtright (2003), professors facilitating members' discussion guided the discussion by providing appropriate prompts, questions, or suggestions; thus, while members did have some social conversation the discussions were always relevant to the topics. To conclude, effective online discussion needs to have members' sustained participation and presence and supportive CMC tools (Watson, 1997). However a discussion facilitator, such as professors or members with authority, may also be needed to facilitate and monitor the discussion. The results of members' usage of DB, CR, RS, and other social awareness tools in Sakai supported what previous studies have shown. Previous studies found that CMC tools can deliver social awareness information and facilitate social in-

teraction in online learning environments (Carroll, et al., 2003; Alavi, 1994; Dourish & Bly, 1992) as well as facilitate communities of practitioners for solving practical problems (Jonassen, et al., 1995). These results were consistent with prior research that studied teachers' professional learning (Gray & Tatar, 2004; Job-Sluder & Barab, 2004) and found CMC tools can foster and support members' asynchronous and synchronous discussion.

According to Wenger (1998), mutual engagement of participants, joint enterprise, and shared repertoire are three dimensions of the community of practice. The discussions in DB and CR showed NETwork members' mutual engagement as well as joint enterprise for teaching practice. Wenger (1998) said that "Practice does not exist in the abstract. It exists because people are engaged in actions whose meanings they negotiate with one another" (p. 73). In NETwork, members were engaged not only in DB and CR but also sharing resources in Resources. During the interaction, they negotiated meanings of practical teaching and of what others presented in the community. For example, they discussed the strategy: "Give me 5" on the discussion board, where through discussion they negotiated a common meaning for using this strategy in practice. Additionally, joint enterprise is a source of community coherence and is generated via members' collective processes of establishing members' mutual accountability (Wenger, 1998). Member's growth in understanding teaching knowledge and skills as expressed in the NETwork discussion and interviews revealed joint enterprise in teaching practices. Members expressed how they appropriated others diverse insights into their own thinking and opinions. For example, pre-service teachers mentioned that a good teacher should be able to communicate with parents efficiently after participating in the NETwork discussion topic: "Parents." The growth of members' joint enterprise is a result of interacting with others in the community. Further, shared repertoire is developed in a pursuit of joint enterprise when negotiating meanings of practice. One substantial example is that the resources shared in RS by professors or other members in NETwork were recognized by members to be supportive for their learning to teach.

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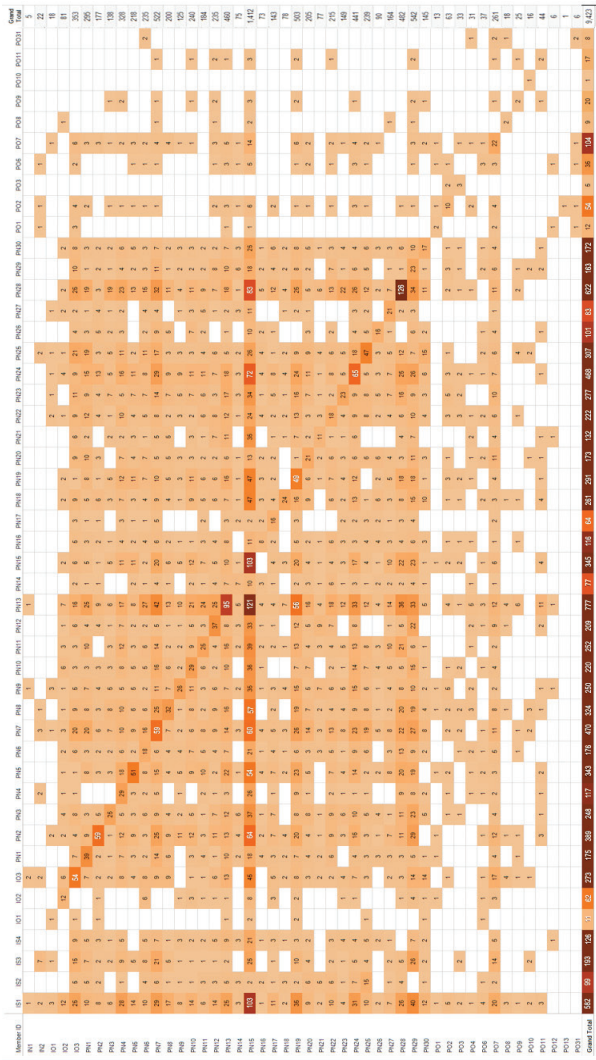
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APPENDIX

Appendix A: Interaction Patterns in DB



Note. a. Color shows count of Frequency. Darker color represents higher frequency of interaction, and vice versa. b. The text values show the count of the frequency of interaction. c. The frequency ranges from 1 to 126.

Appendix B: Social network analysis indices for DB

Members	Out-degree (M=172.38, SD=159.04)		In-degree (M=172.38, SD=203.94)	
	Rank		Rank	
PN13	1	725	6	378
PN28	2	577	5	402
PN7	3	436	4	425
PN24	4	434	7	360
PN2	5	355	21	129
PN5	6	318	16	175
PN15	7	317	1	1234
PN8	8	296	19	152
PN25	9	287	14	185
PN19	10	267	3	429
PN23	11	262	22	124
IO3	12	254	8	280
PN18	13	245	30	56
PN11	14	234	18	154
PN9	15	232	26	96
PN3	16	229	25	110
PN22	17	207	15	179
PN10	18	201	12	203
PN12	19	190	13	193
PN1	20	163	10	256
PN6	21	160	13	193
PN30	22	157	24	113
PN20	23	155	17	167
PN29	24	147	2	455
PN21	25	123	28	62
PN16	26	109	28	62
PN4	27	102	9	270
PO7	28	94	11	211
PN26	29	91	27	76
PN27	30	72	20	142
PN14	31	70	29	59
PN17	32	52	23	115
PO2	33	46	31	51
IO2	34	45	28	62
PO6	35	32	34	30
PO9	36	18	35	22
PO11	37	16	39	0
IO1	38	10	37	13
PO1	38	10	32	41
PO8	39	8	36	14
PO31	40	7	39	0
PO3	41	4	33	32
PO4	42	0	34	30
IN2	42	0	37	13
IN1	42	0	38	4
<hr/>				
		Network Centralization (Out-degree)	10.62%	
		Network Centralization (In-degree)	20.39%	
		Network Density	3.62 (SD=10.13)	

Note. N=45

Appendix D: Social network analysis indices in RS

Members	Rank	Out-degree (M=5.97, SD=6.91)	Rank	In-degree (M=5.97, SD=10.25)
PO33	1	28	20	0
PO21	2	26	20	0
PO34	2	26	20	0
PO23	3	19	20	0
PO6	4	16	19	1
PO22	5	15	20	0
PO25	5	15	20	0
PO4	6	14	20	0
PO1	6	14	20	0
PO38	7	11	20	0
PO27	8	10	20	0
PO3	8	10	20	0
PO37	9	9	20	0
PO16	9	9	20	0
PO35	9	9	20	0
PO20	9	9	12	9
PO26	10	8	20	0
PO30	10	8	20	0
PO24	10	8	20	0
PO42	10	8	20	0
PO14	11	7	20	0
PO28	11	7	20	0
PO29	11	7	20	0
PO32	12	6	20	0
PO17	12	6	20	0
PO2	12	6	20	0
PO31	13	5	20	0
PO7	13	5	3	37
PO15	13	5	20	0
PO12	13	5	20	0
PO18	14	4	20	0
PO19	14	4	20	0
PO13	15	3	20	0
PN8	15	3	7	19
PN20	16	2	18	2
PN24	16	2	18	2
PN19	16	2	1	43
PN3	17	1	2	42
PN1	18	0	10	14
IO3	18	0	17	3
PN17	18	0	18	2
PN18	18	0	15	5
PN15	18	0	11	11
PN12	18	0	4	25
PN25	18	0	14	6
PN26	18	0	15	5
PN10	18	0	5	21
PN29	18	0	14	6
PN13	18	0	14	6
PN30	18	0	9	16
PN16	18	0	18	2
PN6	18	0	8	18
PN7	18	0	10	14
PN27	18	0	16	4
PN9	18	0	6	20
PN21	18	0	15	5
PN22	18	0	19	1
PN4	18	0	13	8
IN2	18	0	15	5
Network Centralization (Out-degree)			4.83%	
Network Centralization (In-degree)			8.12%	
Network Density			.10 (SD=.47)	

Note. N=59