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LEARNING TO TEACH

Effectiveness of an Online Community of Practice

for Learning to Teach Elementary Science

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Abstract

The purpose of this study was to understand how teachers participate in and benefit from an online community of practice (NETwork) for learning to teach. Dependent-samples t-tests were employed to examine the significant differences of members' perceptions of their social experience, while content analysis was utilized to identify members' perceptions of their growth in learning to teach from participation in NETwork. The results show significant positive changes in members' perceptions of social navigation, perceived ease of use and usefulness of the NETwork tools, and satisfaction with NETwork experiences. Also, members reported they found NETwork to be effective in supporting their current/future teaching and that their interactions in NETwork led to a sense of community.

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Introduction

Taking advantage of the ease of access and affordability of the Internet, universities and researchers have been establishing and testing online learning experiences not only for traditional course-based learning but also for communities of practice (CoP). The development of Internet technology and concepts of CoP offer potential for diminishing the gaps and disconnection 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 studies (Job-Sluder & Barab, 2004; Gray & Tatar, 2004; Roup, Gal, Drayton, & Pfister, 1993; Steele, 2002; Desimone, Porter, Garet, Suk Yoon, & Birmnan, 2002) have found online systems effective in supporting the continuum of teachers' professional development but not easy to sustain. NETwork (Nurturing Elementary Teachers' work), an online community of practice for learning to teach, was established using Sakai 2.0 to support the collaboration and professional discourse between university teacher educators, pre-service teachers, and in-service teachers. To better understand the potential benefits of CoP and how teachers can be supported and sustained while participating online, this study investigated the effectiveness of NETwork for engaging the various members and for supporting their learning to teach.

Theoretical Perspectives

Community of Practice (CoP)

A CoP is a group of people who join together with a common purpose and share a common practice (Wenger, 1998). Lave and Wenger (1991) in exploring how learning is situated

in social practice describe how activities are inherently social and shaped by the context. The practice and context influence one's sense of identity, how and what is learned, and the meaning of practice in the context. How members work and interact socially in CoP shapes learning and practice. In the community, members integrate practice, meaning, identity, and community as components of learning and knowing in their interaction. Lave and Wenger (1991) said "Activities, tasks, functions, and understandings do not exist in isolation; they are part of broader systems of relations in which they have meaning. These systems of relations arise out of and are reproduced and developed within social communities, which are in part systems of relations among persons" (p.53).

Learning is social, and one's growth depends on not only changes of feelings and cognition but also the shared values, relationships, networks, and knowledge reproduced in the interaction. 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). Learning and membership in a community are intertwined as members' identities change gradually from peripheral participation to more core roles as they gain more knowledge of practice and enhance their sense of membership by having a sense of belonging and having others to ask for support (Wellman & Gulia, 1999). Members' experiences of learning in CoP are constructed through their engagement and participation. Although members join CoP based upon their own interests, they must have positive engagement, such as social bonds and relationships with others, to sustain their membership. In the process of engaging or participating in practices, joint enterprise (e.g., mutual accountability and negotiating discourse) can be produced and maintained in a shared space as shared repertoire. The shared repertoire becomes members' resources for further negotiating in practice. The

changes in members identities, indicating how they perceive who they are and how other members think about them, is a result of their participation and engagement in online learning and interaction (Wenger, 1996). Similarly participation and engagement then shape identity and shared meanings in the community.

Computer-Mediated Communication Tools Support CoP

In online CoP the tools that support the establishment of members' communication, social relationships, and interaction are critical. Wellman and Gulia (1999) have recognized that communities can exist as social networks where members do not need to be physically in the same location. The spirit of community and communion among members are found to be more important than having a sense of physical place (Ward, 1999). Additionally, Jonassen, Davidson, Collins, Campbell, and Haag (1995) believed that "technology can be used to create communities of learners and practitioners and can facilitate the interactions and activities necessary for solving real-world problems" (p. 8). Having computer-mediated communication (CMC) tools to support asynchronous and synchronous interaction of CoP, time and space are not necessarily limitations anymore. In CoP, the task-realted and social content of communication is what brings people together. Without physical interaction, member's physical characteristics become invisible and the textual content of communication is carried by the CMC tools. Textual information delivered by CMC tools is the primary way members in CoP shape their understanding and feelings of learning content and others' identities. Thus, members know each other primarily from what they said but not the characteristics of their physical looks or interactions.

Hillman, Willis, and Gunawardena (1994) argued that users' learning is blocked if they cannot interact through the medium easily. The technologies and tools need to be easy for

members to use in order to facilitate interaction. In order to promote effective collaboration during online learning, researchers have examined how synchronous and asynchronous CMC tools can deliver social awareness information and facilitate social interaction in online learning environments. Studies have found that social interaction can be supported by CMC tools if CMC tools are applied effectively (Tu & Corry, 2003; Lavooy & Newlin, 2003; Tu & McIsaac, 2002; Kearsley, 2000). The qualities of the CMC tools influence how members socialize and how they appropriate and adopt the practices of interacting and participating in mediated CoP. Members' learning is dependent upon the CMC tools being well designed to support communication and social interaction in ways that fit the context.

Professional Continuum in Teacher Education

The National Science Education Standards (NSES) calls for science teachers to synthesize content and pedagogy through an inquiry-based approach. However, what transpires in the typical science classroom is more often characterized as presentations of a collection of facts and discussion of textbook readings, or a barrage of disconnected activities (Anderson & Smith, 1987; Gee, Boberg, & Gabel, 1996; Moscovici, 1998; Prather, 1993). Recent research indicates that K-12 science teachers often lack sufficient knowledge and competence to teach science effectively (Akerson, 2006; Ball, Heather, & Bass, 2005; Bleicher, 2004; Lindgren and Bleicher 2003; King, Shumow, & Lietz, 2001; Schibeci & Hickey, 2000). This problem is coming to be recognized as a systemic issue in teacher development. Despite having the NSES describe a continuous, career-long process of learning in which science teachers have regular, sustained opportunities to engage in inquiry, knowledge acquisition and integration, reflection, and collaboration (NRC, 1996), the current status of science teacher education does not effectively connect teachers' university preparation and continued education throughout their

careers (Kahle & Kronebusch, 2003). The deficiencies of knowledge and skills for science

teachers are partially explained by poor collaboration and connectedness between schools of

education and K-12 education, isolation during teachers' induction year, and the discontinuity of

teachers' professional development across their career-long lives (Goodlad, 1990; Kahle &

Kronebusch, 2003).

Teacher education reform has emphasized practices which link teacher education to

practicum, induction year, and teaching life; however, the science teacher education continuum

has been criticized as "a fractured system, lacking both continuity and accountability" (Kahle &

Kronebusch, 2003, p. 585). Universities typically regard pre-service preparation as their task,

and the responsibility for new teacher induction rests on schools (Feiman-Nemser, 2001). The

emphasis of reform-based practices has not resulted in wide-sweeping improvements to K-12

instruction (Smith, Banilower, McMahon, & Weiss, 2002). During induction, for example,

novice teachers are often overwhelmed with the number of duties and responsibilities that are

part of their teaching job (Kagan, 1992; Fessler & Christensen, 1992) and the feelings of

isolation that characterize teaching alone for the first time (Holt-Reynolds, 1995). As such,

novice teachers may rely on whatever practices enable them to survive, whether or not these are

best practices. Rather than implementing reform-based practices learned in their teacher

education program, they may "adopt ways of thinking and acting that place them in harmony

with the existing occupational culture" (Schempp, Sparkes, & Templin, 1993, p. 448).

Feiman-Nemser argued teacher education programs represent only a "weak intervention

compared to the influence of teachers' own schooling and their on-the-job experience"

(Feiman-Nemser, 2001, p. 1014). To better sustain teachers' learning through stages of

professional development, Feiman-Nemser (2001) identified the central tasks (Table 1) across

stages of teachers' professional development as they progress throughout their careers. She also

emphasized that teachers need to be facilitated in these tasks through each stage.

Table 1

Central Tasks of Learning to Teach (Feiman-Nemser, 2001)

Pre-service Teacher Education	*Induction of Beginning Teachers*	*Continuing Professional Development*
Examine beliefs critically in relation to vision of good teaching	Learn the context- students, curriculum, and school community	Extend and deepen subject matter knowledge for teaching
Develop subject matter knowledge for teaching	Design a responsive instructional program	Extend and refine repertoire in curriculum, instruction, and assessment
Develop an understanding of learners, learning, and issues of diversity	Create a classroom learning community	Strengthen skills and dispositions to study and improve teaching
Develop a beginning repertoire	Enact a beginning repertoire	Expand responsibilities and develop leadership skills
Develop the tools and dispositions to study teaching	Develop a professional identity	

From the perspective of the social theory of learning, teachers may face barriers to their

social development though they may be committed to personal development. Mostly, teachers

work alone in their classrooms and feel isolated from colleagues by norms of autonomy and

noninterference (Little, 1990; Lortie, 1975; Feiman-Nemser, 2001). Thus, teachers often lack

connections with colleagues who work in different areas but have similar interests, and rarely

have opportunities to discuss their problems with someone who is familiar with the same

subjects or situations. This is particularly problematic for novice teachers which may lead to the

difficulties of their induction years. However, as Feiman-Nemser emphasizes, if new teachers

"learn to ask for clarification, share uncertainties, and request help (p.1030)" they can develop

knowledge and skills for improving their teaching. Therefore, there is a need to assist teachers to

establish their teaching social network where they can find support by sharing ideas and

discussing teachings. Additionally, research recognizes that change in practice and teacher learning happens over an extended period of time, not through "one-shot" workshops (Loucks-Horsley et al., 1998; Richardson & Placier, 2001). Teachers' opportunities for reflection and learning may increase in professional development activities such as workshops and conferences; however, the gains from these activities are often not maintained afterwards. Effective professional development draws from "the collective wisdom that thoughtful teachers can generate by working together" (Feiman-Nemser, 2001, p. 1042). Further, a review of research on professional development reinforces that teacher interaction in a context of trust, collegiality and community is important for the acquisition and activation of professional knowledge (Wilson & Berne, 1999). Effective professional development is embedded into the ongoing practice of teaching and related to teachers' concerns and problems (Feiman-Nemser, 2001). It recognizes that teachers function as a community of practice. Taking advantage of synchronous and asynchronous communication in the virtual space, teacher online learning communities promoting a continuous and collaborative learning environment for teachers in their career lives, may enable innovative solutions to bridge the gap between teacher education and school practice. These virtual communities also have potential to transcend boundaries caused by geographical distribution, provide extended opportunities for teacher collaboration outside of work, and be "safe" venues for teachers to share problems and seek assistance (Barab, MaKinster, Moore, Cunningham, & the ILF design Team, 2001b; Gray & Tatar, 2004).

Social Nature of Online Learning and Participation & Interaction in CoP

Vygotsky (1978) stated that learning is a process of social interaction, including negotiation, collaborative sense making, constructing joint knowledge, and mentoring knowledge construction by people working together. Wenger (1996) in developing a social theory of

learning defines participation as "the social experience of living in the world in terms of membership in social communities and active involvement in social enterprises (p.55)" and argued 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" (p.22). Through the process of negotiating meaning, learners construct their own understandings based on their experiences and prior knowledge. When negotiating and making sense, learners interact with experienced learners and gain their expertise by participating in negotiation and collaboration for better understanding the new knowledge or skills (Jonassen, 1994; Vygotsky, 1978). Online students' active participation has been found to be critical in sustaining a learning community and building a sense of community (Wang, Sierra, & Folger, 2003). Brown (2001) and Moller, Harvey, Downs, and Godshalk (2000) found that members' active participation in collaborative activities can foster their sense of community. Since learning is constituted through social interaction, a sense of community and social ability influence learners' participation and outcomes (Rovai, 2003; Carroll, 2001; Putnam, 2000; Laffey, Lin, & Lin, 2006).

Vrasidas and McIsaac (1999) suggested that structure, class size, feedback, and students' prior experiences with CMC all influence interaction in an online course. Especially, content and immediacy of feedback from others impact members' interaction and levels of participation. Wagner (1994) said that "feedback automatically elicits the correct response without the student being actively aware that learning is taking place. In contrast, cognitivists maintain that feedback serves as information to the learner: the learner actively interprets the information and uses it to generate responses" (p12). Feedback establishes reciprocal relationships and social interaction among members of CoP. Additionally, the use of different types of synchronous and asynchronous CMC tools (chat, discussion board, blog, etc.) that enable members to socially

interact with others have been shown to influence students' participation and ways of interaction in online learning (Collins & Zane, 1996). Falvo and Solloway (2004) also found that the types of online learning format, technology used for supporting learning, instructional design, and various social activities and relationships contribute to a greater sense of community and are found to impact participants' interaction. Participants have been show to be satisfied with the format of online learning because of the convenience of learning at their own pace and location. Previous studies indicated that people's sense of community, social ability, and technology acceptance are three primary constructs impacting social interaction and participation in CoP.

Measurement of Teachers Professional Development in CoP

According to the social theory of learning, members' learning and growth is demonstrated not only in participation and social interaction but also in cognitive changes and changes to teaching practices. A review of ten empirical studies of teachers' professional learning community was conducted by Vescio, Ross, and Adams (2006). These ten studies all supported the idea that changes in teaching practice result from participating in a learning community. These studies assessed how teachers' learning in professional learning communities improved their teaching in practice by comparing students' achievement, comparing class teaching of teachers with and without participating in the community, comparing teachers' practice before and after participating in the community, and interviewing teachers about their changes in teaching and perceptions of teaching. For example, Phillips (2003) compared students' achievement scores within a three-year period and reported the achievement of students whose teachers participated in the learning community increased dramatically. Similarly, Berry, Johnson, and Montgomery (2005) compared students' achievement over a four-year period in a middle school whose teachers were engaged in a learning community. The results showed

teachers' learning did lead to students' improvement on grade level testing. Additionally, Dunne, Nave, and Lewis (2000) compared practices of teachers who participated with those who did not participate in the learning community (Critical Friends Groups, CFG) via interviewing teachers and observing classroom teaching. They found teachers who participated in CFG had more experience in sharing teaching ideas and samples of students' work, discussing classroom problems regularly, and working together to develop learning activities and materials. Englert and Tarrant (1995) compared transcripts of taped weekly project meetings which showed changes in instruction and teaching strategies for those who participated in the learning community. Within the studies that utilized interviews to assess teachers' changes, Vescio, Ross, and Adams (2006) found that some studies (e.g., Dunne, et al., 2000; Hollins, et al., 2004; and Strahan, 2003) collected detailed information of teachers' perceptions of the changes, including how their particular changes in teaching strategies or instruction were applied in classes, but some studies (e.g., Andrews and Lewis (2003), Phillips (2003), and Whitford and Fisher (2003)) did not., Andrews and Lewis (2003), Phillips (2003), and Whitford and Fisher (2003) only reported teachers' general perceptions of changes in practice and thinking in their studies. Teachers' self reported data through interview, survey, or discussions from project meeting are frequently used in studies of the effects of PLC.

According to Vescio, Ross, and Adams's (2006) review, the two primary methods to directly assess teachers' professional development from participating in CoPs are to observe their classroom teaching and compare their students' achievement before and after their participation. However, these two methods are difficult to implement when the professional learning community is established online. When teachers are distributed around the country, it is difficult to conduct observations in their classrooms. Also, the studies (Phillips, 2003; Berry, Johnson, &

Montgomery, 2005) that assessed students' achievement to find the effectiveness of the professional communities took from 3 to 4 years to see the effects of teachers' learning. The influence of teachers' participating in the CoP might not be reflected immediately in their teaching or students' performance. It might take several years or longer to show the effects. An asset in assessing how well teachers learn in online professional learning communities is that teachers' interaction and discussion can be automatically recorded in the system. Some previous studies have employed content analysis of members' asynchronous and synchronous discussion content and interviews of teachers' self-reported perception and reflection of learning in the CoP.

Additionally, for some online professional learning communities that are particularly integrated with workshops (e.g., web-supported community) or online courses (e.g., online courses provided by teacher education programs), it is possible to collect members' grades or required assignments or projects to assess how well members learn in the CoP. For example, in a qualitative study that investigated the value and effectiveness of online workshops as a tool for developing teachers' professional learning community, Yang and Liu (2004) used individual assignments, a report, and three group projects as sources to assess students' growth from the learning activities. In addition to these artifacts of participating in the community, content analysis of members' discussion was employed and a survey was administered to explore members' attitudes about participating in the community. Brett (2002) studied online engagement and community among pre-service mathematics teachers enrolled in an experimental two-year certification course. Data were collected from database notes, math content tests, interviews, questionnaires, and portfolios of 20 students. Based upon results from previous studies and the constraints of studying an online CoP, interviews, surveys, and content analysis of discussion content to examine teachers' perception of their learning and how their

learning influenced their current or future teaching seem appropriate methods.

Research Question

The purpose of this study was to understand how pre-service teachers and in-service teachers benefit from an online community of practice for learning to teach. The effectiveness of NETwork for learning how to teach focused on the process of members' participation and experience in NETwork. Thus, members' perception of the social nature of learning in the community and their experience and feelings of learning to teach were the primary consideration of this study. Below are the two research questions for this study.

1. How do members' perceptions (sense of community, social ability, ease of use, usefulness, satisfaction with their NETwork experience, and effectiveness of NETwork for supporting teaching) change through participating in the community?

2. How do members experience and feel about the effectiveness of NETwork for learning how to teach?

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. To support members' communication and social interaction, Sakai 2.0 is a open source including not only the basic communication tools, such as discussion board for asynchronous discussion, chat room synchronous discussion, resource space for sharing files, announcement tool, assignment space for release and submit assignments, and grading book, but also social presence box for knowing who is around and notification feature for knowing when the new messages were posted. The purpose of NETwork at a mid-west state 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 learning environment.

The key features of NETwork include (a) communication tools: synchronous and asynchronous

discussion tools, file sharing space, and some notification and social awareness tools; and (b)

learning tasks: asynchronous topic discussions, synchronous chat discussion sessions, and

teaching resources and lesson plans sharing. Members of Network include (a) K-8 pre-service

teachers who started their field teaching or student teaching; and (b) K-8 in-service teachers who

graduated from the teacher education program of two mid-west universities where the faculty

member who maintains the site had taught. Pre-service teachers' participation started with their

enrollment in one of the teaching methods courses in the teacher education program, while

in-service teachers (former students of the faculty member) accepted the professor's invitation

through out the Fall 2006 and Spring 2007 semesters. Members who participated since Fall 2006

semester were classified as old members and members joining in Spring 2007 are called new

members.

Additionally, NETwork is not just a CoP within an online course. While it does integrate

some activities for pre-service teachers 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 pre-service teachers, NETwork members included pre-service and

in-service teachers who were not taking the teaching methods courses. Also, most of the

NETwork activities were not requirements of what pre-service teachers were doing in their field

experience courses. In addition to professors, there were a total of 92 members in NETwork.

Table 2 presents the demographic information for 49 members who participated both in the first

and final surveys.

Table 2

Demographic Information for 49 Participants

Demographic Information		Number of Participants	Percentage (%)
Gender	Male	3	6.1
	Female	46	93.9
Age	Under 20	6	12.2
	21-25	41	83.7
	26-30	2	4.1
	>30	0	0
Membership	Old member (since Fall06)	26	53.1
	New member (since Spring07)	23	46.9
Teaching Status	Pre-service teacher (Old member)	24	49.0
	Pre-service teacher (New member)	23	46.9
	In-service teacher (Old member)	2	4.1
	In-service teacher (New member)	0	0
Participation of NETwork Discussion	participator	37	24.5
	non-participator	12	75.5
Previous Online Learning Experience	In Sakai	44	89.8
	In Blackboard	46	93.9
	In other systems	3	6.1
Messages Posted in Discussion Board (weekly)	less than 2 postings	20	40.8
	3-5 postings	10	38.8
	6-8 postings	5	10.2
	8-10 postings	5	10.2
Hours Login(weekly)	less than 1 hour	23	46.9
	1-5 hours	26	53.1
	6-10 hours	0	0
	>10 hours	0	0

Instruments

The items for assessing the social constructs were adapted from previous studies (Davis, 1989; Rovai, 2002; Laffey et al., 2006; Yang, Tsai, Cho, Kim, & Laffey, 2006; Alavi, 1994). Both the early and later surveys included 5 primary constructs: technology acceptance, sense of community, social ability, learning satisfaction, and effectiveness of NETwork for teaching. For the content items of social constructs, participants were asked to rate their agreement with the items on a 7 point Likert-type Scale where 1 represented strongly disagree and 7 meant strongly agree.

Technology Acceptance. The 10 items of these constructs were adapted from an online

learning experience survey (Yang et al., 2006; Tsai, Kim, Liu, Goggins, Kumalasari, & Laffey, 2008) based upon Davis's technology acceptance instrument (Davis, 1989). The Cronbach α reliability of perceived ease of use and perceived usefulness assessed in the previous study were .96 and .98 (Tsai, et al., 2008).

Sense of Community. The 20 items for sense of community were adapted from Rovai's Classroom Community Scale (Rovai, 2002), which measures sense of community in an online learning environment. The Cronbach α reliability of connectedness subscale and learning subscale are reported as .92 and .87 (Rovai, 2002).

Social Ability. The 18 items of social ability were adapted and modified from a 30-item instrument of online learning experience (Laffey et al., 2006). Advances to the original instrumentation (Yang et al., 2006) found students perceived instructor's social presence and peers' social presence differently. Based upon this result, this study examined social presence with professors (instructor role: professor or mentor, 6 items) and social presence with peers (peer role: pre- and in- service teachers, 6 items) separately. The Cronbach α reliability of social navigation, social presence with instructor, and social presence with peers were .88, .93, and .91 (Laffey et al., 2006).

Satisfaction with NETwork Experience. Nine items to measure members' satisfaction with NETwork experience were modified to meet the context of this study from a previous online learning experience study (Laffey et al., 2006; Yang et al., 2006) which developed items based upon Alavi's (1994) learning and evaluation scales. The items for course evaluation were modified to examine the community by changing the description from referencing a course to the NETwork community. The Cronbach α reliability of overall satisfaction of online learning were .92 and .87 for learning satisfaction and .89 for course evaluation (Tsai, Yang, & Laffey,

2008).

Effectiveness of NETwork for Teaching (ET). The 10 items about how members perceive

the value of participating in NETwork were developed by the authors to address how members

feel about their teaching knowledge, skills, and confidence after participating in NETwork. Two

expert reviews were conducted for developing these items in August 2006. An expert in science

education reviewed the items to ensure the questions could address members' feeling of their

improvement/change of the content and pedagogical knowledge in science teaching. After that,

an expert in social computing reviewed the questions to ensure questions were realistic and

meaningful to measure members' changes after participating in an online learning community.

Data Collection

To address the research questions, a set of semi-structured serial interviews were

implemented throughout the semester, a final semi-structured interview was conducted at the end

of the semester, the first survey was implemented early in the semester, and a final survey was

undertaken at the end of the semester. The purpose of a set of semi-structured serial interviews

were to examine the changes of members' perceptions of their participation and interaction

across the semesters, while the purpose of the purpose of the final semi-structured interviews

were to help collect more students' perception of learning in the NETwork. In addition to

interviews, the pre and post surveys help to collect quantitative data from a broader scale of

participants and help triangulate our understanding of how members interact in the NETwork.

The interview and survey data were collected during Spring semester 2007 for NETwork.

In the second week of the Spring 2007 semester, an invitation email requesting members'

participation in the serial interviews and final interviews was sent to 92 members. A total of 5

members agreed to participate in the serial interviews, while 8 members consented to participate

in the semester-end interview. The eight members who participated in the semester-end

interview were selected from the members who did not participate in the serial interviews in

order to collect members' summary judgments about the NETwork experience. Members who

participated in serial interviews were interviewed three times throughout the semester in order to

capture members' changes in how they experienced learning in NETwork. The first serial

interview was conducted in the fifth week of the semester, while the second and the third serial

interviews were implemented in the tenth and fourteenth weeks. Additionally, invitation emails

recruiting members' for participation in the first and final survey were sent to 92 members in the

fifth week and fourteenth week of the semester. A total of 55 out 92 members completed the first

survey, while 66 members completed the final survey. Table 3 shows the time schedule of the

data collection and the number of members who participated in the surveys and interviews.

Table 3

Research Participants

Types of NETwork Members		N	Serial Interviews	Semester-end Interviews	First Survey	Final Survey
Experienced Members (Since Aug. 2006)	Pre-service Teachers (PO)	38	2	2	25	32
	In-service Teachers (IO)	17	1	2	2	4
New Members (Since Jan. 2007)	Pre-service Teachers (PN)	30	2	4	23	30
	In-service Teachers (IN)	7	0	0	0	0
Total		92	5	8	50	66
			During Spring 2007 semester	End of the Spring 2007 semester	5th week of the 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 Analysis

The quantitative data, collected from the first survey (pre-test) and final survey (post-test),

were analyzed by dependent-samples t-tests to examine if members' perceptions of social

constructs changed after participating in the NETwork. The qualitative data, including transcripts

of serial interviews and semester-end interviews, were analyzed via content analysis to provide

descriptive information to support what was found in the one-way repeated measurements. Since

this study sought to understand members' social experience in NETwork, a combination of the

framework of Community of Practice (Laffey, 2005) and Interaction Analysis Model (IAM)

developed by Gunawardena et al. (1997) were adapted to develop a coding scheme for serial

interviews and a coding scheme for semester-end interviews. Since members often presented

several ideas in response to a single interview question, the theme and idea analysis unit (Morse

& Richards, 2002) was applied to the content analysis of interview transcripts. Additionally, the

coding scheme of the serial interviews was developed from coding the first three serial interview

transcripts, while the coding scheme for semester-end interviews was adapted from the serial

interview coding scheme and tested on one semester-end interview. To reach inter-rater

consensus, the primary researcher generated the drafts of the coding schemes after coding the

first set of serial and semester-end interviews. Later another researcher coded the same

interviews by using the drafts of the coding schemes independently. The different coding results

were discussed and resolved, and the coding schemes were finalized (Appendix A). The rest of

the interviews were coded by the researchers independently and discussed to obtain consensus in

the results. The steps of content analysis are presented in Appendix B.

Results

Dependent-samples T-tests

Before conducting the dependent-samples t-tests, the assumptions of independence of

observations, normality, linearity, and homogeneity of variance were examined and found to be

satisfactory. There were no univariate outliers found in the examination with criteria z scores

greater than 3.29 and less than -3.29. Additionally, the number of the paired cases for the analysis is relatively small. According to Stevens (1996), when the group size is small, there is a possibility that a non-significant result may result from insufficient power, which indicates a risk of Type II error. Stevens (1996) suggests adjusting the alpha level (from traditional .05 to a cut-off of .10 or .20) to compensate for the small group sizes (Pallant, 2001). Given the small group sizes in this study, a range of cut-off alpha levels are used for comparisons to help avoid making Type II errors (risk of accepting a null hypothesis that should have been rejected.). The levels are set at 0.05 (***), .10 (**) and .20 (*). However, in minimizing the risk of making Type II errors, the risk of making Type I errors becomes relatively higher compared to using the lower cut-off alpha level. Thus, to further contend against the risk of Type I errors caused by adjusting alpha values from .01 or .05 to.10 or .20, the effect sizes were calculated to provide further information for judging the comparisons.

The dependent-samples t-tests include two phases. Phase one comparisons use pre-test (first survey) and post-test (final survey) scores from Spring semester 2007. However, phase two analyses were made using data collected from the pilot study in Fall semester 2006. In the first phase, the dependent-samples t-test was to examine if both in-service and pre-service teacher in the NETwork community perceived social constructs differently after participating in the NETwork. The results shown in Table 4 indicate five variables, including social navigation (SN), perceived ease of use (PEU), perceived usefulness (PU), satisfaction with NETwork experience (S), and site evaluation (SE) have significant differences between the pre- and post-test.

Table 4

Results of Phase I Dependent-samples T-test

| Constructs | Survey07-Pre | | Survey07-Post | | T-test | | | |
| | | | | | 90% C.I. | | t | Sig. |
	M	SD	M	SD	Lower	Upper		(2-tailed)
Sense of Community (SOC)	4.74	1.05	4.91	.99	-.39	.05	1.27	.21
Social Ability (SA)	4.87	1.25	4.98	1.26	-.36	.14	.75	.46
Social Presence with Peer (SPp)	4.90	1.29	5.08	1.37	-.50	.15	.92	.37
Social Presence with Instructor (SPi)	4.98	1.28	4.90	1.36	-.20	.36	-.46	.65
Social Navigation (SN)	4.73	1.45	4.97	1.35	-.49	.02	**1.55***	**.13**
Perceived Ease of Use (PEU)	4.72	1.69	5.10	1.51	-.68	-.07	**2.07*****	**.04**
Perceived Usefulness (PU)	4.62	1.70	4.87	1.50	-.54	.05	**1.41***	**.16**
Satisfaction with NETwork experience (S)	4.55	1.62	4.83	1.66	-.61	.06	**1.37***	**.18**
Effectiveness of NETwork for Teaching (ET)	4.64	1.69	4.93	1.72	-.67	.10	1.26	.22

*Note. N=49; * p < .20, **p < .10, *** p < .05*

The obtained mean value of social navigation (post test: M=4.97, SD=1.35; pre test: M=4.73, SD=1.45; t(48) = 1.55, p < .20) was found to be significantly higher after participation in the NETwork. Also, participants expressed an increase in their perception of ease of use (post test: M=5.10, SD=1.51; pre test: M=4.72, SD=1.69; t(48) = 2.07, p < .05) and usefulness (post test: M=4.87, SD=1.50; pre test: M=4.62, SD=1.70; t(48) = 1.41, p < .20) of the NETwork learning tools in Sakai. Satisfaction with NETwork Experience (post-test: M=4.83, SD=1.66; pre-test: M=4.55, SD=1.62; t(48) = 1.37, p < .20) in the post-test was significantly greater than that of the pre-test. Additionally, the eta squared values for SN (eta squared = .05, PEU (eta squared = .08), PU (eta squared = .04), and S (eta squared = .07) indicate moderate and large effects, which support the finding that NETwork members perceived greater SN, PEU, PU, S, and SE after participating in the NETwork for one semester.

However, the length of time participating in a community of practice may be an important influence on how members experience the community and on the impact of

community. For example, a time period of one semester may be too short to find any changes in members' perception of sense of community. Thus, the purpose of implementing the phase II dependent-samples t-tests was to examine if time length of participating in NETwork impacts the significance of members' change in perceptions. The pre-test survey data collected in Fall semester 2006 (Survey06 Pre-test) in the pilot study were paired with the survey data collected in the Spring semester 2007 (Survey07 Post-test) for one dependent-samples t test, and the data collected in the final survey for Fall semester 2006 (Survey06 Post-test) were paired with the Survey07 Post-test for another dependent-samples t-test. Therefore, only the members who both participated in the surveys in the pilot study and the survey07 post-test were included in the phase II dependent-samples t-tests. Also, the examinations focused on the social constructs which were included on both surveys.

The results of the first dependent-samples t-test shown in Table 5 indicate that four variables, including sense of community (SOC), perceived ease of use (PEU), perceived usefulness (PU), and effectiveness of NETwork for teaching, had significant differences between the survey06 pre-test and survey07 post-test (8 month difference).

Table 5

Results of Phase II Dependent-samples T-test (8 months)

| Constructs | Survey06-Pre | | Survey07-Post | | T-test | | | |
| | | | | | 90% C.I. | | t | Sig. |
	M	SD	M	SD	Lower	Upper		(2-tailed)
Sense of Community (SOC)	4.48	.49	5.25	.60	-1.14	-.412	3.92***	.00
Perceived Ease of Use (PEU)	5.08	.90	5.73	.96	-1.29	-.01	1.86**	.09
Perceived Usefulness (PU)	4.53	.91	5.88	.91	-1.85	-.85	4.97***	.00
Effectiveness of NETwork for Teaching (ET)	4.28	1.18	6.26	.86	-2.46	-1.51	7.69***	.00

Note. N=10, old members participate in survey06-pre & survey07-post; * $p < .20$, **$p < .10$, *** $p < .05$

The obtained mean value for the sense of community post test (M=5.25, SD=.60) was

found to be significantly higher than the pre test (M=4.48, SD=.49; t(9) = 3.92, p < .05) for old

members (survey06 pre & survey07 post). Also, old members (survey06 pre & survey07 post)

perceived higher ease of use (post test: M=5.73, SD=.96; pre test: M=5.08, SD=.90; t(9) = 1.86,

p < .10) and usefulness (post test: M=5.88, SD=.91; pre test: M=4.53, SD=.91; t(9) = 4.97, p

< .05) of the NETwork learning tools in Sakai. The old members' (survey06 pre & survey07 post)

perception of the effectiveness of NETwork for Teaching (post-test: M=6.26, SD=.86; pre-test:

M=4.28, SD=1.18; t(9) = 7.69, p < .05) in the post-test is significantly greater than that in the

pre-test. Additionally, the eta squared values for SOC (eta squared = .63), PEU (eta squared

= .28), PU (eta squared = .73), and ET (eta squared = .87) indicate moderate and large effects,

which support the finding that the older members who completed both survey06 pre-test and

survey07 post-test perceived greater SOC, PEU, PU, and ET after participating in the NETwork.

Additionally, the results of the second dependent-samples t-test shown in Table 6 indicate

three variables, including sense of community (SOC), social navigation (SN), and perceived ease

of use (PEU) have significant differences between the survey06 post-test and survey07 post-test

(5 month difference).

Table 6

Results of Phase II Dependent-samples T-test (5 months)

	Survey06 -Post		Survey07 -Post		T-test			
					90% C.I.		t	Sig.
Constructs	**M**	**SD**	**M**	**SD**	**Lower**	**Upper**		**(2-tailed)**
Sense of Community (SOC)	4.99	.56	5.31	.51	-.60	-.04	**2.14****	**.07**
Social Ability (SA)	5.73	.59	5.55	1.09	-.29	.66	-.73	.49
Social Presence with Peer (SPp)	5.59	.69	5.54	1.37	-.65	.76	-.14	.89
Social Presence with Instructor (SPi)	5.68	.76	5.70	1.23	-.47	.44	.08	.94
Social Navigation (SN)	5.93	.72	5.41	.98	-.11	1.15	**-1.53***	**.16**
Perceived Ease of Use (PEU)	5.42	.65	5.92	.94	-1.06	.06	**1.66***	**.14**
Perceived Usefulness (PU)	5.53	1.13	5.89	.95	-1.02	.30	1.02	.34
Effectiveness of NETwork for Teaching (ET)	5.91	.75	5.99	.84	-.47	.30	.40	.70

Note. N=9, old members participate in survey06-post & survey07-post; * *p* < .20, **p < .10, *** *p* < .05

The obtained mean post-test value of sense of community (post test: M=5.31, SD=.51;

pre test: M=4.99, SD=.56; t(8) = 2.14, p < .10) was found to be significantly higher as well as were the mean values for ease of use of the NETwork learning tools in Sakai (post test: M=5.92, SD=.94; pre test: M=5.42, SD=.65; t(8) = 1.66, p < .20). However, an interesting finding in the opposite direction of our expectation was that old members (survey06 post & survey07 post) perceived lower social navigation (post test: M=5.41, SD=.98; pre test: M=5.93, SD=.72; t(8) = -1.53, p < .20) after participation in the NETwork in Spring 2007. Additionally, the eta squared values for SOC (eta squared = .36), SN (eta squared = .23), and PEU (eta squared = .26) indicate moderate and large effects, which support the findings that older members completed both survey06 post-test and survey07 post-test perceived greater SOC and PEU and lower SN after participating in the NETwork.

A comparison of the results of the first and second dependent-samples t-test in the phase II analysis shows that the level of the significant difference of SOC (changed from p < .05 to p < .10) and PEU (changed from p < .10 to p < .20) was reduced when the time difference between implementing two surveys is reduced from about 8 months to 5 months. Also, the level of the significant difference of ET (criteria met p < .05) and PU (criteria met p < .10) were found to be significantly different when the time difference between two surveys is about 8 months (2 semesters). The results of the comparison indicate the possibility that some social constructs need longer time periods to impact perceptions.

Content Analysis for Serial Interviews and Semester-end Interviews

The purpose of the content analyses for members' serial interview and semester-end interviews was to identify salient issues in members' experiences when participating in NETwork. By analyzing the serial interviews, seven themes were found for members' perceptions of social constructs after participating in NETwork. These seven themes are (a)

members' appreciated the ways NETwork supported their learning to teach similarly but with a few differences across member types; (b) in-service teachers/old members and pre-service teachers reported a contribution of NETwork discussion to their perceptions of a good teacher's characteristics; (c) members wanted to keep NETwork memberships because they wanted to keep accessing diverse insights about teaching and teachers across states; (d) members indicated an increase in teaching confidence resulting from participating in NETwork activities; (e) members' sense of community changed positively throughout the semester; (f) members perceptions of the social presence indicator in the "present box" of Sakai site became more positive throughout the semester; and (g) in-service teachers/old members and pre-service teachers identified advantages of the notification tool, daily email digest, to facilitate their participation in NETwork.

Additionally, the results of the content analysis for semester-end interviews yield eight themes regarding members' perceptions of social constructs after participating in NETwork. These eight themes are (a) members expressed that NETwork provided them access to diverse insights about teaching and to practical experiences (e.g., teaching philosophy, a good teacher's characteristics, knowledge of potential students, and class management, etc.); (b) members felt that they were not alone when facing teaching problems or issues because NETwork provided a safe space for them to share positive and negative teaching experiences; (c) members felt that NETwork provided them wide opportunities to connect to other teachers across the nation; (d) members perceived NETwork as part of their teaching support system for finding help when needed; (e) members' teaching confidence increased after seeing other members' concerns and problems and by engaging with diverse insights in discussion ; (f) members expressed how their participation helped build a sense of community in NETwork; (g) the social present box

displaying members' names when they were online helped members experience social presence and social navigation; and (h) the topic information shown through the notification tool, daily email digest, influenced members' decisions about logging-in to NETwork.

Discussion

Members who participated in NETwork in Spring 2007 semester had significant changes from early in the semester to later in the semester in their perceptions of social navigation (SN), ease of use (PEU) and usefulness (PU) of Sakai tools, and satisfaction with NETwork experience (S). Although members' perceptions of effectiveness of NETwork for teaching, sense of community, and social ability were not significantly different in the quantitative data, members who participated in interviews expressed the effectiveness of NETwork for their current or future teaching, changes in their sense of community via interacting with others in online discussions or chats, changes in their perception of other members' social presence via Sakai tools, and how effectively they used the Sakai tools to socially interact with other members. These qualitative results may indicate that some changes take longer to develop or perhaps are not as widespread across the community as others. Additionally, it should be noted that the early scores for social constructs satisfaction and effectiveness are all relatively high. To verify if some social constructs need longer time periods to show significant differences, an examination of the phase II dependent-samples t-tests comparing members' perception after participating for two semesters in NETwork found that members had significant differences in their perceptions of sense of community (SOC), perceived ease of use (PEU) and usefulness (PU) of Sakai tools, and effectiveness of NETwork for teaching (ET). Measures of social ability were first measured in the final survey in Fall 2006. Statistically, with a small sample size (only 10 and 9 POs' responses) in these two extended examinations, the t-test results tend to be non-significant.

However, as shown in the extended examinations, SOC, PEU, PU, ET, and SN were found significant, indicating the value of measuring members' perceptions of these social constructs, including SOC, ET, SN, or SA, over a longer-time-period of participation in NETwork.

After participating in NETwork activities, members expressed the effectiveness of participating in NETwork for their current or future in-school teaching. Members stated that they perceived the effectiveness of NETwork for their teaching via gaining diverse insights of others' teaching experiences, discussing and discovering good teachers' characteristics, discussing the characteristics of their current or potential students, gaining knowledge and skills of class management and assessment, teaching ideas, working with parents, and having emotional support from other members. To summarize, pre-service teachers experienced a growth in their understanding of practical teaching issues via discussing contemporary teaching experiences and concerns with in-service teachers, other pre-service teachers, and professors. Additionally, members' feelings of teaching confidence were enhanced by seeing others' experiences, questions, and concerns about teaching and by answering or providing help to others in the NETwork community. For example, in-service teachers stated that talking to other people was helpful to improve their teaching confidence, while pre-service teachers felt seeing others viewpoints and hearing others' agreement or compliments for their teaching insights enhanced their teaching confidence. These findings are consistent with what Brown and Duguid (2000) found in that members learn to be practitioners by working and talking about practice. In Brown and Duguid (2000), they concluded that "practice is an effective teacher and the community of practice is an ideal learning environment." Also, this result confirms that pre-service and in-service teachers benefit from being members of a community with a sense of belonging and having others to ask for support (Wellman & Gulia, 1999).

Further, members expressed that the more they kept themselves exposed to or participated in the NETwork discussion and activity, the more they felt an increase in their sense of community and felt comfortable interacting with other members. This finding is consistent with prior studies (Wang, Sierra, & Folger, 2003; Brown, 2001; Moller et al., 2000) showing that students' active participation can sustain a learning community and contribute to a sense of community. Also, Rovai (2003, 2002a) showed that members' sense of community influenced learners' participation and outcomes, and Yang et al. (2006) demonstrated that social ability influenced learners' participation. Similar to Rovai (2003) and Yang et al. (2006), the qualitative results of this study illustrate that sense of community is fostered when members feel a sense of other members' social presence. As an example, members described that seeing others' name appearing in the presence box made them feel someone was working with them at the same time and encouraged them to read or check to see if any new postings were created by these members who were shown to be present. This finding is aligned with the significant direct and indirect relationships between members' perception of social presence with instructors and peers and sense of community. To summarize, NETwork is an evolving community of practice (Wenger, 1998) where members' growth, participation, interaction, and feeling of the community are interwoven and highly associated. Members' behaviors and feelings were influenced by what others did, what they saw, and what they accessed in the community. The growth of the community includes not only individual members' growth but the implicit changes and improvement of the community itself.

Importance of the Study

This study contributes both theoretical and practical implications for online learning and teacher education. While it is important to keep in mind that every CoP will be different and

even that the same CoP will be different over time as membership and practices may change, the

results of this study show the potential of CoP for engaging and benefiting members. The results

of this study show NETwork to be effective in developing a sense of community, engaging

members through computer-mediated learning and work, and benefiting knowledge, confidence

and perceptions of one's self as an effective teacher. These results should help researchers better

understand the potential effectiveness of an online community of practice for teaching and how

members may act and interact in an online learning community without course-based

requirements. Members' perceptions of how the NETwork help them to learn to teach contribute

to advancing theory about CoP and social learning and can be utilized to improve the activities

and tools of CoP to provide members a comfortable and supportive online learning environment.

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Appendix

Appendix A: Coding Schemes for Serial Interview and Semester-end Interview

I. Coding Scheme for Serial Interview

Coding Unit: Paragraph & Sentence

Nodes	Description & Indicators
Identity	- Participants addressed their background information.
Experience of NETwork	- Participants talked about their experience of participating in the NETwork.
1. Login Frequency	- Participants mentioned how many time he/she login weekly or during a time period.
2. Interaction with others	- Participants described how he/she interacted with others in the NETwork.
a. Discussion Board Experience	- Participants shared her/his experience about participating in DB discussion.
b. Information Sharing	- Participants shared information or resources to others.
3. Goal of participating in NETwork	- Participants described their goals of participating in the NETwork.
Ways to reach the goals	- Participants described how they could reach the goals and what might be issues regarding to it.
4. Concerns and Suggestions	- Participants described what they do not like about the NETwork or anything in the NETwork that needs to be improved.
a. Time Concerns	- Participants expressed their time concerns about participating in the NETwork.
5. Feel about Notification	- Participants expressed how they felt about the notification email (Email Digest).
b. Influence of Notification Email	- Participants expressed how the notification email (Email Digest) influenced their action in the NETwork.
6. Changes of experiences	- Participants described what had changed by participating in the second month or third month.
7. Changes of Identity	- Participants addressed how they felt about their role or identity changed after participating in the NETwork.
Community and Belonging	- Participants expressed how they felt about the community and other members or being in the groups.
1. Social Presence	- Participants described how they felt about the presence box in the left side of the SAKAI worksite.
Practice and doing	- Participants addressed what he/she learned from the ideas others provided and report back with the results.
Teaching Belief and Perception	- Participants described what their teaching belief and perception are.
1. Characteristics of a good teacher	- Participants described what characteristics a good teacher should have.
2. Knowledge and Skills needed	- Participants described what knowledge and skills they would like to learn more for being a good teacher.
3. Satisfaction with what have learned	- Participants expressed their satisfaction with what they have learned.
Effectiveness of NETwork for Teaching	- Participants describe the effectiveness of NETwork for their teaching.
1. Sharing Resources	- Participants described what they liked and felt helpful of the resources shared in the NETwork.
2. Global Opportunities	- Participants described the global opportunities of connecting to other teachers around the country NETwork provided.
3. Teaching Knowledge and Skills	- Participant described how much their teaching knowledge and skills improved or increased because of participating in the NETWork.
4. Teaching confidence	- Participants described the changes of their teaching confidence after participating in the NETwork.
5. Teaching supports	- Participants described if they satisfied with the teaching supports they had and how they felt about it.

II. Coding Scheme for Semester-end Interview

Coding Unit: Paragraph & Sentence

Nodes	Description & Indicators
Identity	- Participants addressed their background information.
Experience of NETwork	- Participants talked about their experience of participating in the NETwork.
1. Login Frequency	- Participants mentioned how many time he/she login weekly or during a time period.
2. Interaction with others	- Participants described how he/she interacted with others in the NETwork.
a. Discussion Board Experience	- Participants shared her/his experience about participating in DB discussion.
b. Information Sharing	- Participants shared information or resources to others.
3. Goal of participating in NETwork	- Participants described their goals of participating in the NETwork.
Ways to reach the goals	- Participants described how they could reach the goals and what might be issues regarding to it.
4. Concerns and Suggestions	- Participants described what they do not like about the NETwork or anything in the NETwork that needs to be improved.
a. Time Concerns	- Participants expressed their time concerns about participating in the NETwork.
5. Feel about Notification	- Participants expressed how they felt about the notification email (Email Digest).
b. Influence of Notification Email	- Participants expressed how the notification email (Email Digest) influenced their action in the NETwork.
Community and Belonging	- Participants expressed how they felt about the community and other members or being in the groups.
1. Social Presence	- Participants described how they felt about the presence box in the left side of the SAKAI worksite.
Practice and doing	- Participants addressed what he/she learned from the ideas others provided and report back with the results.
Teaching Belief and Perception	- Participants described what their teaching belief and perception are.
1. Characteristics of a good teacher	- Participants described what characteristics a good teacher should have.
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3. Satisfaction with what have learned	- Participants expressed their satisfaction with what they have learned.
Effectiveness of NETwork for Teaching	- Participants describe the effectiveness of NETwork for their teaching.
1. Sharing Resources	- Participants described what they liked and felt helpful of the resources shared in the NETwork.
2. Global Opportunities	- Participants described the global opportunities of connecting to other teachers around the country NETwork provided.
3. Teaching Knowledge and Skills	- Participant described how much their teaching knowledge and skills improved or increased because of participating in the NETWork.
4. Teaching confidence	- Participants described the changes of their teaching confidence after participating in the NETwork.
5. Teaching supports	- Participants described if they satisfied with the teaching supports they had and how they felt about it.

Appendix B: Steps for Content Analysis

Procedure	Purpose	Results
Step 1: Develop the coding schemes	- To prepare a draft of the coding schemes based on the framework of CoP (Wenger, 1996) and AIM (Gunawardena et al., 1997)	- Coding schemes for serial interview and semester-end interview were developed. The coding nodes for each coding schemes were defined.
Step 2: Try the coding schemes	- To test if there is anything that needed to be modified when coding the first few transcripts or discussion content. - To modify the coding schemes based on the testing.	- 3 serial interviews (1 set) and 1 semester-end interview were analyzed based on the coding schemes. - Some nodes in the coding schemes were merged and adjusted.
Step 3: Discussion the coding schemes with the inter-rater	- To ensure if the coding schemes made sense to another researcher (the inter-rater). - To ensure both raters had same understanding of the definitions for the nodes. - To modify the coding schemes	- Based on the opinions of the inter-rater, the coding schemes had been modified. The inter-rater took the coding schemes back and read through it more careful to prepare for the testing in the next step.
Step 4: Test the inter-rater's understanding of the nodes of the coding schemes via examples abstracted from the real coding content.	- To ensure the inter-rater had same understanding with the primary researcher. - To develop the coding book	- Scores were given to the inter-rater's answer for the testing coding content. The inter-rater had correct answers: 8.5/10 for both serial and semester-end interviews. - The wrong coding answers in the test were discussed and clarified. - A coding book with some coding examples was developed after the discussion.
Step 5: Independent coding of samples, including 3 serial interviews (1 set) and 1 semester-end interview	- To ensure both researchers understand how to apply the coding scheme for coding the data.	- Both researchers coded the same samples by using the coding book to guide the coding.
Step 6: Compare the results of the independent coding.	- To ensure both researchers have same understanding of what should be coded for the nodes. - To clarify and resolve the differences of the coding results	- After comparison, the percentages of the same coding answers were at least over 80%. * SI: 94% for the first serial interview coding results, 86% for the second serial interview coding results, 85% for the third serial interview coding results. * FI: 80% for the semester-end interview coding results - The difference of the coding results were resolved and clarified again.
Step 7: Finish coding independently	- To conduct coding for all the transcripts and discussion content	- Both raters finished coding 100% of the rest of descriptive data independently.
Step 8: Compare the results of 100% coding content the inter-rater finished	- To calculate the inter-rater reliability for the coding results.	- After comparison, the different coding results were discussed and resolved to reach a finalized 98% to 100% agreement.