

Effects of Communication Competence and Social Network Centralities on Learner Performance

Il-Hyun Jo^{1*}, Stephanie Kang¹ and Meehyun Yoon²

¹Department of Educational Technology, College of Education, Ewha Womans University, Seoul, Korea //

²Department of Learning, Design, and Technology, College of Education, University of Georgia, USA //

ijj3174@gmail.com // stephaniekang83@gmail.com // meehyun@uga.edu

*Corresponding author

(Submitted August 13, 2012; Revised March 11, 2013; Accepted February 21, 2014)

ABSTRACT

Collaborative learning has become a dominant learning apparatus for higher level learning objectives. Much of the psychological and social mechanisms operating under this complex group activity, however, is not yet well understood. The purpose of this study was to investigate the effects of college students' communication competence and degree centralities of their social networks on learning outcomes in a collaborative learning situation. The study participants were 63 students of educational technology at a women's university in Korea. Path analyses of the data using NetMiner 3.4 and AMOS 7.0 indicated that: 1) communication competence caused trust network degree centrality ($\beta = .24, p = .13$), 2) communication competence caused knowledge sharing network degree centrality ($\beta = .46, p = .00$), 3) trust network degree centrality enhanced knowledge sharing network degree centrality ($\beta = .41, p = .00$), and 4) knowledge sharing network degree centrality affected individual students' learning outcomes ($\beta = .55, p = .00$). The study results revealed the significant collective effects of network degree centrality measures and individual communication competence on learners' performance. Based on these results, implications for team organization strategy and future research directions are discussed.

Keywords

Collaborative learning, Social network analysis, Communication competence

Introduction

Background and purpose of the Study

The purpose of collaborative learning is to develop students' attitude and competence to interact and collaborate to pursue common goals, while reducing the sense of alienation and hostility from the traditional class situation that creates a high level of competitive spirit (Slavin, 1995). Unlike individual learning, collaborative learning enhances interdependency in groups based on individual learner's competence and the sense of responsibility. Therefore, the effectiveness of collaborative learning depends on social condition in the team, as well as individual cognitive and affective factors (Johnson & Johnson, 1994).

Social Network Analysis (SNA) has received attention both as a theory and as a method to understand and analyze the social attributes of a learning group (Jo, 2008). SNA can be an appropriate measure to investigate the characteristics and pattern of interpersonal relationships and even of the communicative interaction within a certain group (Cho, Gay, Davidson & Ingraffea, 2007; Reffay & Chanier, 2002). A social network approach can also be applied to measure the degree and strength of social ties within a social system and to develop models of community structures (Girvan & Newman, 2002). In this perspective, a social network acts as a conduit of information and knowledge and assists in the formation of social capital such as trust among members of the society, and is appropriate to explain collaborative learning situation (Borgatti, Everett, & Freeman, 2002).

SNA considers that the network structure and individual position in the network are the key factors that decide the group action as collaborative learning. It has its epistemological root in structuralism. However, there is a strong counter argument against this structural determinism perspective on SNA. This counter argument is based on the critical mind that individual roles such as individual competences and effort are ignored (Jo, 2008). The argument that reflects their critical mind above is that it is still impractical to underestimate the effect of a learner's independent role, or agency, and responsibility on the formation and development of a network, even though the attribute of the network and the individual position in that network play important roles in collaborative learning. In

this context, research examining how the individual role and responsibility influence the network is necessary. We can expect that an individual variable, especially communication competence, is related to network development in a collaborative learning situation because it directly influences communication (McCroskey, 1987), which is known as a strong predictor for dense social network.

It can therefore be inferred that communication competence enhances individual centrality and position, and that this enhanced position has a positive effect on collaborative learning outcome. However, no reported empirical research has investigated the effect of individual variables and social variables on group performance.

The purposes of this study are: 1) to investigate the effects of college students' communication competence on the degree centralities of their social network, and 2) to analyze empirically how their communication competence is related to their learning outcome in a collaborative learning situation.

The specific study questions are:

- Does communication competence of the individual affect the degree centrality of knowledge sharing network?
- Does communication competence of the individual affect the degree centrality of trust network?
- Does trust network affect knowledge sharing network centrality?
- Does knowledge sharing network centrality affect individual learner performance?

This study is worthwhile as it examines how communication competence, an individual attribute, affects network centrality and performance in a face-to-face collaborative learning situation in university. This study is expected to contribute to real world practices by defining what instructors should consider in terms of forming and operating a collaborative learning team.

Literature review

Communication skills

The concept of communication competence

Communication researchers have been considered that, just as intelligence, differences in communication competence exist between individuals. When trying to communicate with any people in different relationship, people show different behavior within several types (McCroskey, 1987; Richmond & Roach, 1992). Much of this behavior is attributed to the competence of individuals (Norton, 1978). Norton's multivariate communication style assumes that nine independent variables and one dependent variable can determine and describe communication style construct. Similarly, Rubin & Martin(1994) developed an interpersonal communication competency scale (ICCS) consisting of 10 self-reported measures of ICC skills which were reduced from the original 60 skills. In this scale, ICC refers "an impression or judgment formed about a person's ability to manage interpersonal relationships in communication settings." Communication competence is a natural property to some trait but is also a developed competence by interacting with the context of communication environment. For example, in public speaking, discussion in a small-group collaborative learning, and one-on-one talking with friend, different types of communication competence are expressed depending on the communication context, and a long-term exposure to a particular environment can help developing appropriate communication competence for it (McCroskey & McCorseky, 1988). In addition, we can assume that an individual who is willing to communicate both verbally and nonverbally in a situation tends to have a positive interpersonal relationship. Freeman (2004) also considered communication competence (or communication adaptability) as an enhanceable personal competence as socio-interpersonal relationship develops and at the same time, competence to be needed to develop interpersonal relationship and adapt interaction behavior.

Communication competence and collaborative learning

Empirical studies have been performed to identify the hypothetical relationship between communication competence and collaborative learning. The results of these studies confirm that in collaborative learning situations, an

individual's communication competence and types of communication play an important role in learning outcome and team activities (i.e., Jeong, 2005; Allen, Long, O'Mara, & Judd, 2007).

In collaborative learning situations, learners are exposed to various types of communications. One-on-one conversation with colleagues, small group discussions with team members gathered, and presentation to target the entire class is the communication situations that are frequently performed in collaborative learning in college classes. Thus, an individual's overall communication competences during collaborative learning activities can be expected to play an important role.

According to Richmond and McCroskey (1998), Andersen and colleagues' (Andersen, Norton, & Nussbaum, 1981) study researched independently in face-to-face classroom environment, communication competence of teachers and students had a significant influence on cognitive learning outcomes, as well as the learner's ongoing emotional learning intentions. In addition, an individual's competence, which enables open, friendly, and responsive communications, creates active participation and innovation thinking in collaborative learning. Furthermore, it is reported as being related to effective behavior to deliver those innovative thinking (Allen, Long, O'Mara, & Judd, 2007).

In collaborative learning, the importance of mediating activities related to communication such as dialogue, collaboration, and social exchange has been consistently emphasized. Specifically, an individual's communication competence positively affects various group collaborative activities and, ultimately, creates a trust network, which is a team that is able to trust each other (McCroskey, 1987). In addition, in a learner group with more excellent communication competence, more seamless sharing of knowledge activities tends to be made more frequently (Kilduff, 1992). Furthermore, it has been reported that leaders with outstanding communication competence get strong support from members, which enables the leaders to exert leadership effectively and, ultimately, contribute to organizational performance results (Richmond & McCroskey, 1998). Based on the results of these previous studies of collaborative learning situation that conducted in the context of business corporate education, it is predictable that learner's communication competence enables more effective communication and also contributes to the learning outcome by facilitating the trust and knowledge sharing within team.

Social network analysis

Social network analysis and degree centralities

SNA is a mathematical analysis tool that displays the social structure diagrammatically in the form of nodes and links that connect each node (Jo, 2008). This analysis is based on a view of structuralism in the way that social relational phenomenon, collaboration and knowledge sharing, can be explained more appropriately by an actor's location in the network structure than the individual property of the actor (Freeman, 2004).

In SNA, the unit of analysis is divided on the microscopic level, which is aimed at an individual actor, and the macroscopic level, which is aimed at the network. First, at the microscopic level, the act of exchanging social, cognitive, or material resource by an individual actor(a node) and the other actor(another node) pairing with a link is analyzed. This relationship between the pair may be strong or weak depending on the opponent. Degree centrality frequently used in SNA is a typical microscopic indicator that represents the degree of linkage (Wasserman & Faust, 1994).

Degree centrality and communication competence

Little previous research has examined the effect of individual variables such as communication competence on the formation and development of a social network within a group. The constructivist view that many SNA researches implicit tends to exclude the possibility that a psychological factor could have been a crucial part in deciding individual behavior (Burt, Janotta, & Mahoney, 1998; Kilduff, 1992).

Meanwhile, some social network researchers have recognized the empirical fact that an individual character plays an important role in the formulation of a relationship with others (e.g., Burt et al., 1998; Mehra, Kilduff, & Brass,

2001). Mostly in a business corporation context, these researchers studied how the individual attribute affects the structure of the social network within organization. They found that individual communication competence not only decides the position in the network that is measured in the degree centrality within the organization (Burt et al., 1998), but that it is also a predictor that leads to social strategic distinction (Mehra et al., 2001). Specifically, people with an entrepreneurial personality take a brokerage position in a network (Burt et al., 1998), while people with an introspective personality proactively utilize the degree centrality in the network to increase their influence within the organization (Mehra et al., 2001).

Studies that attempt to determine the relationship between the type of individual communication and the network index have examined cooperation organization. Thus, from these previous studies it was hard to find direct empirical reference to connect synthetically how communication competence and type affect the social network in collaborative learning context. After examining previous studies that examined the relationship between communication and collaborative learning, collaborative learning and SNA, this study will deduce implications in collaborative learning context by connecting the findings of the two studies.

Degree centrality and learning outcome in collaborative learning

Degree centrality is calculated as the number of links that an individual actor has, and it reflects the individual actor's network activity intuitively. In SNA, a person with a high degree centrality is a center actor who is defined as a person who has the largest number of links with other actors within a particular communication group or network (Picciano, 2002). This indicator focuses on prominent actors in the group. The person is interpreted as a positive person in the relational process. Conversely, the person whose index is low can be judged as someone who plays a marginal role in the group.

Thus, individuals with a high degree centrality are likely to have a favorable position in the network in two ways. First, relatively less effort is required when finding the information source from fellow students. Because learners with high degree centrality can find and access sources of information quickly and easily, because they are well known to fellow students in the team and class and because they know who knows what. Second, people with high degree centrality can exert a powerful influence when they acquire information from sources that they found. This is because degree centrality acts as prestige and influence within a network (Wasserman & Faust, 1994). Collaborative learning is a network phenomenon so that such general traits of degree centrality are expected to appear in collaborative situation similarly (Jo, 2008).

Based on these theoretical possibilities, empirical studies that identify the relationship between degree centrality and collaborative learning outcome have been performed. Papa and Tracy's study showed that people with a high degree centrality within an organization also achieved high learning outcomes (Papa & Tracey, 1988). Jo conducted research on collaborative learning teams in college courses, identified how in-degree centrality of trust network affects individual outcome and how knowledge sharing out-degree centrality affects team outcome (Jo, 2008). Another study conducted in a blended learning environment integrated by classroom and e-learning which studied the correlation between relevant variables such as various network centrality and learning outcome, and discussion quality. In the results of those studies, advice network centrality and friendship network centrality had positive correlation with learning outcome, while hostile network centrality had negative correlation with most of the performance variables.

Research has been performed on the impact of social network indexes on learning outcomes for short-term performance, as well as on learning team's learning potential and network development for the long-term impact (Jo, 2012). Palonen and Hakkarainen (2000) reported that the degree of network composition is an important precondition for the creation and sustainable development of learning community, since it helps members share cognitive and affective experience and supports informal communication and social activities (Palonen & Hakkarainen, 2000). This collective, social activity lets individual students enhance their belonging within the learning group (Haythornthwaite, 2000).

Trust network and knowledge sharing network

Individuals belong simultaneously to several networks such as high school reunion network, cooperation network in work, and weekend society network. Typical social networks that an individual student can belong to are knowledge sharing network and trust network. There is a relatively direct correlation between these two networks (Jo, 2008).

First, knowledge sharing network plays a direct role in collaborative learning. In the collaborative learning process, the team performance and knowledge expansion of individual members is expected to be improved. Especially in valuable implicit knowledge, the network with the purpose of knowledge sharing between students plays an important role (Wasko & Faraj, 2005). Thus, the process and result of collaborative learning can be influenced by the form and level of knowledge sharing network.

Meanwhile, the trust network indirectly but consistently influences the team outcome by helping the formation and development of a knowledge sharing network (Cross, Parker, & Borgatti, 2000). Kim & Mauborgne (1997) also discussed the importance of trusting atmosphere for improvement of performance by knowledge sharing. In a general knowledge creating situation that knowledge giving is not evaluated as individual level, knowledge giving to others can damage on the knowledge giver's status of knowledge. According to previous studies, when an individual gives knowledge to others, knowledge giver loses one's monopolistic status of knowledge (Thibaut & Kelley, 1959). Thus, if trust is not formulated in the team, people tend not to share knowledge and information with their colleagues that can improve team performance. The development of a trust network between team members is necessary to provide positive criticism on colleague's idea (Misztal, 2001). Previous studies found that unless they trust each other, team performance cannot be improved irrespective of how outstanding and high the individual's level of knowledge (e.g., Cross et al., 2002; Nahapit & Goshal, 1998). To sum up, trust is a factor which makes people to feel less threat when they provide or share their knowledge to other people such as colleagues. The trust network and trust itself have positive influences on knowledge sharing, and trust among team members can build a sense of fellowship so that enables smooth and active production and sharing of knowledge (Cohen & Prusak, 2001). It leads to higher performance of team and organization.

Study hypotheses

Taken together with previous studies, in collaborative learning situation, the individual communication competence of the learner improves the status in social (trust) and cognitive (knowledge sharing) network, which can have a positive effect on improving learner performance. In this, researchers grasped that mutual dependence building is required prior to knowledge sharing. Hence, the researchers formulated the following hypotheses:

Hypothesis 1. Individual communication competence will enhance knowledge sharing network degree centrality.

Hypothesis 2. Individual communication competence will enhance trust network degree centrality.

Hypothesis 3. Trust network will enhance knowledge sharing network degree centrality.

Hypothesis 4. Individual degree centrality of knowledge sharing network will enhance learner performance.

Method

Study procedure

Study Participants

The study participants were 63 students of "Theory of Corporate Education," which was open in the department of educational technology from a women's university located in Seoul, Korea. The objectives of this class, which was established by the principal researcher of this study, were to acquire the basic theories of corporate training and to analyze the current status of applying the approach of educational technology through business field survey.

The 63 study participants were comprised of 42 sophomores (66.7%), 9 juniors (14.3%) and 12 seniors (19.0%), of whom 52 participants (82.5%) were majoring in educational technology while 11 (17.5%) belonged to other

departments. All 63 participants were female because it was held in a women's university. The response rate of the survey was 100 % (63 out of 63).

Process of collaborative learning class

In order to achieve the class objectives, the students were assigned by collaborative learning task in which they should submit a report showing the differences and common elements between corporate education and educational technology after researching the current status of the training and development practices in Korea's business corporations. In order to achieve the high-level learning objectives through conducting various activities including literature analysis, field survey and result analysis, and sharing each member's original knowledge and experience, the collaborative learning based on team units was performed throughout the whole semester.

In the first week of the semester, the researcher organized the students into four (4)-member collaborative learning teams. According to Barkley et al., (2005), the appropriate size of team to improve social skills and mutual interdependence while minimizing the risk of free loaders by collaborative learning is 3 to 4 member group. The goal of the team composition was to create teams with diversity in terms of grade, major and matter of transferring, because a team of diverse members not only creates interdependent collaborative relations between team members (Druskat & Pescosolido, 2002), but also becomes one of the main objectives of collaborative learning based on its experience of diversity. Each team decided the team members in charge of each of the four tasks (data research, analysis & organization, writing a report and writing a presentation data) suggested by the principal researcher. These types of task are regarded as authentic, ill-structured, and requiring team collaboration. (Marks, Zaccaro, & Mathieu, 2000).

In order to expand the width of sharing knowledge and experience that may have been limited by dividing tasks for each team and individual to the level of the whole class, a jigsaw session for each task area was operated twice a month as an activity for the whole class. This provided an opportunity to share problems, data and matters discussed in each team with the whole class.

There was also an opportunity to present the interim results of each team to the whole class once every three weeks. After the other team members filled out the feedback questionnaire anonymously, it was organized as a document by the researchers in charge of the class, and the document was delivered to the relevant team. The feedback questionnaire was comprised of two qualitative and quantitative categories. In the quantitative aspect, the marks (total score: 100) for each category, including the feedback on "presentation data" (detailed items were logicity & systemicity of composition, and fulfillment of the analysis date) and "presentation activity" (detailed items were persuasive power of the presenter and the presentation, and propriety of using the presentation time), were provided to each relevant team. The qualitative evaluation involved filling out a form about the desired requirements. Therefore, this class included the collaborative learning not only for each team, but also for the whole class as in the jigsaw session and feedback from other team members.

Some post-hoc observations

As reported previously, this study relied on data from self-reported surveys, which may be vulnerable to respondents' subjectivity and social desirability. To triangulate the interpretation of the main metric data, a follow-up 2 hour group interview with 15 students who volunteered. The interview data provided some additional information. First, according to the interviewees, the respondents had enough time to carefully read the survey instrument, which provided a relevant level of engagement when answering the survey. Second, the interviewees unanimously agreed that the most relevant group activity was jigsaw session, from which the students gained fresher task perspectives and opportunity to test the original teams' approaches.

Measuring tools

Measuring procedure for each time

In the first week of the semester, individual communication competence was measured. During the semester, the team collaborative learning was continuously conducted. In this process, the researchers carried out an office hour

twice with each team in order to make an interim check of the task performance and feedback. In the 13th week, the degree centrality of social networking was measured to determine the trust within the class and the network for sharing knowledge. The final exam was conducted during the class of the 15th week while collecting tasks for each team in the week after the final exam.

Measuring communication competence

In order to measure individual communication competence, this study used the Self-Perceived Communication Competence (SPCC) scale developed by McCroskey and his colleague (McCroskey & McCroskey, 1988). This measuring tool is comprised of 12 questions that are supposed to be answered with percentages. To answer the relevant questions, a respondent marks 0 points if he/she thinks that he/she cannot do it at all, and marks 100 points if he/she thinks that he/she can do it completely. In order to add up the results of responses for each question, the SPCC tool calculates the average value of the relevant question for four conditions (one-to-one, small group, meeting, public speech) and for three objects (friend, acquaintance, stranger). For example, the score about the stranger is the response average of the average value of four related questions (1, 4, 7, 10), while the score of the group condition is the response average of the average value of three related questions (4, 9, 11). The final score was inserted into the communication competence variable within the model as the average value of the scores of each of seven subordinate areas of SPCC. The reliability (α) of internal questions for each subordinate area was .74 (public), .73 (meeting), .79(group), .84(one-to-one), .87(stranger), .85(acquaintance), and .81(friend), while the overall reliability was .93.

Measuring the degree centrality of social networking

In order to secure the source data needed for measuring individual degree centrality within the class, first the tool of “name-generator” was applied. The questions were comprised of asking to write down names of ‘the five most trusted friends’ and “the five friends who give knowledge the most frequently” in order. By providing different scores from five to one to people mentioned from the 1st to the 5th ranking, the researchers gave the value of degree centrality increased individually. By inputting the matrix data of the added degree centrality between the “person pointing out” and the “person pointed out” into NetMiner 3.4(analytical tool for social networking), the vector of individual degree centrality was calculated.

Measuring the results of learning

The learning results were calculated based on the score added by two subordinate variables such as the individual learner’s understanding of the contents of the class and the excellence of the team assignment. The individual learner’s understanding of the contents of the class (first subordinate variable) was calculated through the total score of the mid-term and final exams that were comprised of ten short-answer questions. The team unit result (second subordinate variable) was calculated through the score of the report-type team project assignment. The title of this report was “Analysis of the current status of applying the instructional system design (ISD) within corporate training in Korea”. In order to write the report, the analytic activities and collecting field data such as interview or survey were required to be included.

For the individual exam score and the evaluation of the team assignment, the marking standard for each type was prepared in advance. After discussing the marking standard with two doctors of educational technology and the researchers, they were marked independently, and the average score of each marker’s score was used for the final score. The assignment score and the sum of midterm and final score were calculated on the scale of one hundred points.

This class condition can reveal the differences of the learners’ efforts put in to prepare the team assignment and midterm/final exams. Such differentiated efforts could work as a chaotic variable. In order to control this, the researchers set up the contribution level weight of both reference variables equally as 50:50, which was announced in the beginning of the semester.

Data analysis

In order for the descriptive statistical analysis of calculation and diagram for the trust network of each collaborative learning team and individual degree centrality within the network for sharing knowledge, the analysis of degree centrality of NetMiner 3.4 (Analyze → Centrality → Degree) was used. The path analysis of AMOS 7.0 was conducted to analyze the causal relations between the variables of the study model. As a method to estimate the parameter for hypothesis testing, the maximum likelihood method was applied while the significance level (α) was set up as .05 in accordance with custom. The study path model and the hypothesis related to each path are shown in (Figure 1) below.

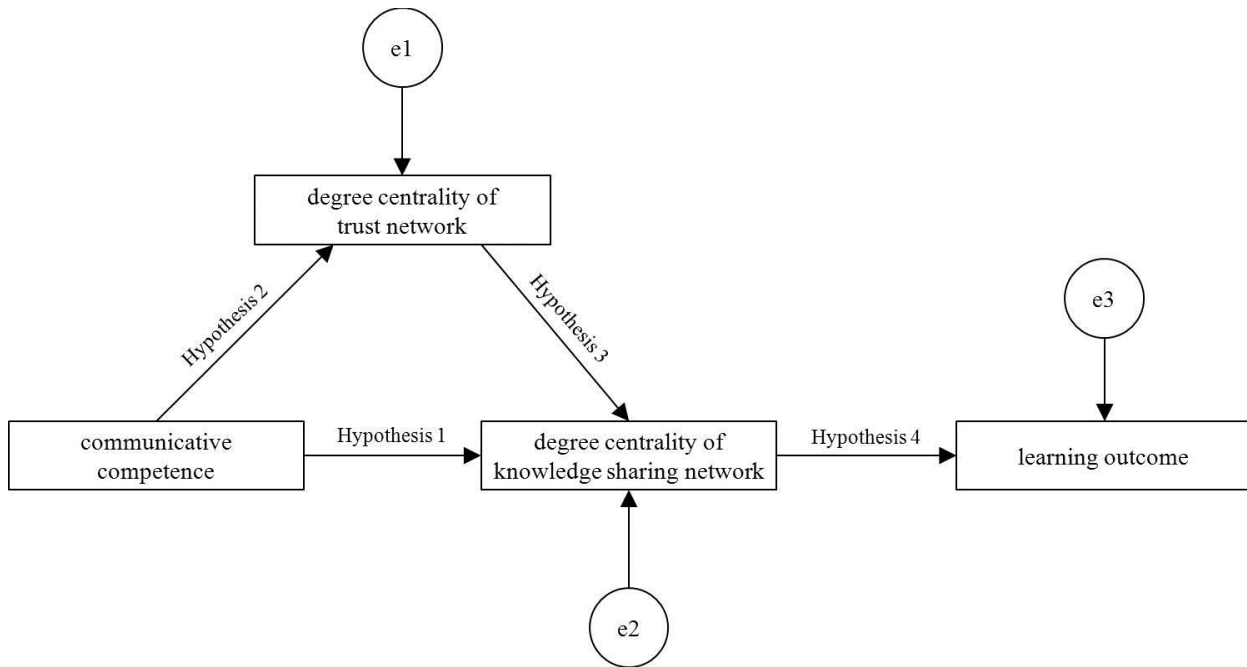


Figure 1. Path model and hypothesis

Results

Basic analysis

Before the path analysis, the normality and multicollinearity of four variables of communication competence, degree centrality of trust network, degree centrality of knowledge sharing network and collaborative learning outcome of college students were tested.

In the examination results of kurtosis, degree of scattering, none of the four variables violated normality. However, there was a slight tendency to a more pronounced positive skew. This observation shows an important feature in common with Barabasi's model of "scale free network". According to Barabasi (2002), networks appear to have positively skewed distribution or power-law distribution in which most nodes have a relatively small number of ties, but a small number of nodes have a disproportionately large number of ties. Since path analysis is known as robust with respect to skewed distribution of predictor variables, and no significant outliers were detected, we decided to conduct significance test as planned.

Learning outcome was measured systematically as described in Method section. However, positive skew was observed in the criteria variable, the learning outcome. Since violation of normality in criterion variable is a threat to path analysis, we conducted statistical manipulation utilizing z-score conversion to alleviate the problem, which did not gain significant improvement. Thus, the p value reported should be conservatively interpreted.

Visual observation did not detect any significant outlier, which is major threat to the linear regression. Visual inspection of data plots and frequency distributions did not identify any outlier

The descriptive statistics and the degree normality of each variable are summarized in <Table 1> below.

Table 1. Descriptive statistics and degree normality

Variable	Average	Standard Deviation	Kurtosis	Skewness
communication competence	76.11	14.20	-.02	-.29
degree centrality of trust network	18.52	11.02	-.28	.28
degree centrality of knowledge sharing network	6.12	4.20	.15	.06
learning outcome	91.21	6.81	-.01	-.25

Next, the tolerance analysis was conducted in order to decide the existence of multicollinearity between the variables. A tolerance of lower than .10 indicated the possibility of multicollinearity (Byrne, 2010) The tolerance result of .545~.681 indicated that the multicollinearity was not detected. Since the major statistical conditions were satisfied, each hypothesis was then tested by the path analysis as planned.

Hypothesis Testing

Correlation analysis was conducted before the path analysis. Because it can provide necessary information for path analysis by simple pair-wise analysis, it can provide the necessary information for the path analysis that considers the direct and indirect relationships among variables (Hoyle, 1995). The correlation matrix is presented in <Table 2> below.

Table 2. Correlation matrix

No.	communication competence(1)	degree centrality of trust network (2)	degree centrality of knowledge sharing network (3)	learning outcome(4)
1	1	.30*	.49**	.56**
2		1	.55**	.43**
3			1	.47**
4				1

* $p < .05$. ** $p < .01$.

Next, the path analysis was conducted to test each of the five hypotheses. The results are presented in <Table 3> below.

Table 3. Results of hypothesis testing

No.	Hypothesis	standardized path coefficient (β)	Significance Level (p)	Acceptance
1	communication competence → degree centrality of knowledge sharing network	.46	.00	Y
2	communication competence → degree centrality of trust network	.24	.13	N
3	degree centrality of trust network → degree centrality of knowledge sharing network	.41	.00	Y
4	degree centrality of knowledge sharing network → learning outcome	.55	.00	Y

Conclusions

Summary of findings

The four main study findings are summarized as follows.

First, communication competence, which is an individual attribute that enables the possessor to occupy the center of the knowledge sharing network, affected collaborative learning outcomes. What is remarkable about learning outcomes of knowledge sharing network is that they are highly explanative ($\beta = .549, p = .000$). Therefore, if the student's communication competence in class is high, the degree centrality of knowledge sharing network is increased and consequently collaborative learning outcomes are increased.

Second, the trust network is not determined only by individual communication competence. Trust is determined by predictability of others in certain circumstance (Misztal, 2001), and needs accumulated group or social experience. It doesn't necessarily mean that communication competence doesn't have predictability on learning outcome (Jo, 2012), but that the effect of the variable is relatively low compared to other variables inserted into the research model. As shown in Table 2, when communication competence and degree centrality of trust network link are focused and the relations of other variables are ruled out, there is a meaningful relation between them ($r = .302, p < .05$).

Third, centrality of knowledge network predicts collaborative learning outcomes with high predictability. The chance of mutual cooperation should be expanded to share knowledge with the whole class as well as the team for increasing the effectiveness of collaborative learning.

Fourth, degree centrality of trust network predicts centrality of knowledge network as result of precedent studies (e.g., Jo, 2008; Wasko & Faraj, 2005). This empirically confirmed again that mutual trust should be required to share the knowledge as shown in Social Capital Theory (Misztal, 2001; Nahapiet & Ghoshal, 1998; Wasko & Faraj, 2005).

Implications

Several implications and future research area related to collaborative learning can be proposed based on the study results.

First, to improve effect of collaborative learning, developing individual communication competence is required. Most of the existing studies for improving the effect of collaborative learning aim to improve the inside condition of collaborative learning by enhancing the team building, type and structure of entitlement, and extent of task distribution. The study results revealed that individual communication competence affects knowledge sharing in a collaborative learning context. Thus, when teams are built, individual communication competence should be considered in the short term, detailed characteristics of communication competence-related knowledge sharing should be established, and the development needs to be studied.

Second, developing instructional strategies of various collaborative learning styles is needed for preserving and expanding the trust of inter-learners, which is a precious network property. However, the problem is that universities are expanding individual competition for good grades because of the unemployment crisis these days, especially in Korea. The spread of this phenomenon of individualism to universities may reduce the meaning and role of collaborative learning and may harm trust network among co-learners. According to Druskat and Kayes (2000), if the team is built by learners' autonomy, the team tends to build a familiarity of learners than their diversity. The more students feel time pressure and a team competitive sense, the more this tendency is increased (Druskat & Pescosolido, 2002). However if the collaborative learning team members know each other well, and have little regard for the learning of others, getting a grade is effective in the short term but expanding learners' knowledge is restrained in the long term (Mehra, et al., 2001). Thus, instructors need to develop team building deeply for effective collaborative learning (Druskat & Kayes, 2000). Upon study completion, the researchers interviewed some of the participants in the group and confirmed the reasonableness of this argument. The participants stated that if they make collaborative learning team autonomically, they tend not to accept new members who are unfamiliar because accepting unfamiliar members is too risky to maximize the team assignment grade in the short term. This team

building tendency is safe in the short term but the width of the student relationships is restrained in the long term; furthermore, the improvement in the trust network may be reduced.

Restriction and follow-up

Due to the following study limitations, extreme care should be taken in interpreting the results.

First, all the participations were women since this research was conducted in women's university. According to a previous study, women respond to relation (or network) sensitively (Palonen et al, 2000). The types of communication are gender specific (Jeong, 2005). Therefore, these study results cannot be generalized. Follow-up study needs to be conducted with a mixed group of participants.

Second, the communication competence was self-reported. From the study results, recognizing competence for oneself is classified with real competence notionally. Therefore, the results of measuring real communication competence may be different from those of this study according to performance assessment. Thus, in following studies, use of performance-based measures of communication competence is recommended.

Third, an attempt was made to analyze the structure of social and contents of interaction, which is a delimitation of quantitative social network analysis method, i.e., quantitative analysis. Especially, contents and meaning of shared language and narrative within the collaborative learning team should be identified and be analyzed poly-synthetically with the quantitative index of network analysis.

Fourth, we did not investigate whether a jigsaw session or the activity of the whole class contributes to the interdependence of the teams. In line with the previous study recommendations, further qualitative observation and rich analysis is needed in order to identify what collaborative learning strategy is necessary for expanding the trust network beyond the individual or team.

Fifth, the present study analyzed the prediction model. For more practical value, the model should be extended to include the effects of interventions for the enhancement of the learning outcome.

Acknowledgements

This work was supported by the National Research Foundation of Korea Grant funded by the Korean Government (NRF-2013S1A5A2A03044140).

References

- Allen, J. L., Long, K. M., O'Mara, J., & Judd, B. B. (2007). The effects of students' predispositions toward communication, learning styles, and sex on academic achievement. *Journal of College Teaching & Learning, 4*(9), 71–84.
- Andersen, J. F., Norton, R. W., & Nussbaum, J. F. (1981). Three investigations exploring relationships between perceived teacher communication behaviors and student learning. *Communication Education, 30*(2), 377–392.
- Barabasi, A. (2002). *Linked: The new science of networks*. New York, NY: Perseus Books Group.
- Barkley, E. F., Cross, K. P., & Major, C. H. (2005). *Collaborative learning techniques: A handbook for college faculty*. San Francisco, CA: Jossey-Bass.
- Borgatti, S. P., Everett, M. G., & Freeman, L. C. (2002). *UCINET for Windows: Software for social network analysis, Analytic Technologies*. Cambridge, MA: Harvard University Press.
- Burt, R. S., Janotta, J. E., & Mahoney, J. T. (1998). Personality correlates the structural holes. *Social Networks, 20*(1), 63–87.
- Byrne, B. M. (2010) *Structural equation modeling with AMOS: Basic concepts, applications, and programming*. New York, NY: Routledge

- Cho, H., Gay, G., Davidson, B., & Ingraffea, A. (2007). Social networks, communication styles, and learning performance in a CSCL community. *Computers & Education, 49*(2), 309–329.
- Cohen, D., & Prusak, L. (2001). *In good company: How social capital makes organizational work*. Boston, MA: Harvard Business School Press.
- Cross, R., Parker, A., & Borgatti, S. B. (2000). A birds-eye view: Using social network analysis to improve knowledge creation and sharing. *Knowledge Directions, 2*(1), 48–61.
- Druskat, V., & Kayes, D. C. (2000). Learning versus performance in short-term project teams. *Small Group Research, 31*(3), 328–353.
- Druskat, V., & Pescosolido, A. T. (2002). The content of effective teamwork mental models in self-managing teams: Ownership, learning and heedful interrelating. *Human Relations, 55*(3), 283–314.
- Freeman, L. C. (2004). *The development of social network analysis*. Vancouver, Canada: Empirical Press.
- Girvan, M., & Newman, M. E. (2002). Community structure in social and biological networks. *Proceedings of the National Academy of Sciences of the USA, 99*(12), 7821–7826. doi: 10.1073/pnas.122653799
- Haythornthwaite, C. (2000). Online personal networks: Size, composition and media use among distance learners. *New Media & Society, 2*(2), 195–226.
- Hoyle, R. H. (1995). *Structural equation modeling: Concepts issues, and applications*. Thousand Oaks, CA: SAGE.
- Jo, I. (2008). Effects of social network centrality on individual and team performances in a collaborative learning environment. *Journal of Educational Technology, 24*(4), 5–30.
- Jo, I. (2012). Shared mental models on the performance of e-learning content development teams. *Educational Technology & Society, 15*(1), 289–297.
- Jeong, A. (2005, October). *The effects of communication style and message function in triggering responses and critical discussion in computer-mediated collaborative argumentation*. Paper presented at 27th International Conference of Association of Educational Communications and Technology, Chicago, IL.
- Johnson, D. W., & Johnson, R. T. (1994). *Learning together and alone: Cooperative, competitive, and individualistic learning*. Boston, MA: Allyn & Bacon.
- Kilduff, M. (1992). The friendship network as a decision-making resource: Dispositional moderators of social influences on organizational choices. *Journal of Personality and Social Psychology, 62*(1), 168–180.
- Kim, W. C., & Mauborgne, R. (1997). “Fair process: Managing in the knowledge economy.” *Harvard Business Review, 75*(4), 65–75.
- Marks, M. A., Zaccaro, S. J., & Mathieu, J. E. (2000). Performance implications of leader briefings and team-interaction training for team adaptation to novel environments. *Journal of Applied Psychology, 85*(6), 971–986.
- McCroskey, J. C. (1987). *Personality and interpersonal communication*. Newbury Park, CA: SAGE.
- McCroskey, J. C., & McCroskey, L. L. (1988). Self-report as an approach to measuring communication competence and personality orientations. *Communications Research Reports, 5*(1), 108–113.
- Mehra, A., Kilduff, M., & Brass, D. J. (2001). The social networks of high and low self-monitors: Implications for work place performance. *Administrative Science Quarterly, 46*(1), 121–146.
- Misztal, B. (2001). Trust and cooperation: the democratic public sphere, *Journal of Sociology, 37*(4), 371–386.
- Nahapiet, J., & Ghoshal, S. (1998). Social capital, intellectual capital, and the organizational advantage. *Academy of Management Review, 23*(2), 242–266.
- NetMiner 3.4. (2009). <http://www.netminer.com>. Seoul, Korea: Cyram Co., Ltd.
- Norton, R. W. (1978). Foundation of a communicator style construct. *Human Communication Research, 4*(2), 99–112.
- Palonen, T., & Hakkarainen, K. (2000). Patterns of interaction in computer-supported learning: A social network analysis. In B. Fishman & S. O'Connor-Divelbiss (Eds.), *Fourth International Conference of the Learning Sciences* (pp. 334–339). Mahwah, NJ: Erlbaum.
- Papa, M. J., & Tracy, K. (1988). Communicative indices of employee performance with new technology. *Communication Research, 15*(5), 524–544.

- Picciano, A. G. (2002), Beyond student perceptions: Issues of interaction, presence, and performance in an online course. *Journal of Asynchronous Learning Networks*, 6(1), 21–40.
- Reffay, C., & Chanier, T. (2002). Social network analysis used for modelling collaboration in distance learning groups. *Lecture Notes in Computer Science*, 23, 31-40.
- Richmond, V. A., & McCroskey J. C. (1998). *Communication apprehension, avoidance, and effectiveness* (5th ed.). Boston, MA: Allyn Bacon.
- Richmond, V. P., & Roach, D .K. (1992). Willingness to communicate and employee success in US organizations. *Journal of Applied Communication Research*, 31(1), 95–115.
- Rubin, R. B., & Martin, M. M. (1994). Development of a measure of interpersonal communication competence. *Communication Research Reports*, 11(1), 33–44.
- Slavin, R. E. (1995). *Cooperative learning: Theory, research, and practice*. Englewood Cliffs, NJ: Prentice Hall.
- Thibaut, J. W., & Kelley, H. H. (1959) *The social psychology of groups*. New York, NY: Wiley.
- Wasko, M. M., & Faraj, S. (2005). Why should I share? Examining social capital and knowledge contribution in networks of practice. *MIS Quarterly*, 29(1), 35–57.
- Wasserman, S., & Faust, K. (1994). *Social network analysis: Methods and applications*. London, UK: Cambridge University Press.