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Sharing Cognition LMS: an Alternative Teaching and Learning Environment for Enhancing Collaborative Performance

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The purpose of this research is to propose a novel social LMS developed for group collaborative learning with a think-aloud tool integrated for sharing cognitive processes in order to improve group collaborative learning performance. In this developmental research, the system was designed with three critical elements: the think-aloud element supports learners through shared cognition, the social network element improves the quality of collaborative learning by forming a structured social environment, and the learning management element provides a understructure for collaborative learning for student groups. Moreover, the three critical elements were combined in an educational context and applied in three directions.

Keywords : Social learning management system (social LMS), SNS, Think-aloud, Collaborative learning, shared cognition

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Introduction

Learning on demand and collaborative learning are progressively becoming frequent terms for new learning types in the era of e-learning 2.0. When discussing about e-learning 2.0, Martins, Gonçalves, Santos, and Pereira (2012) argued that greater learner autonomy in the pursuit of knowledge is one of the emerging characteristics of e-learning on the Web 2.0 or e-learning 2.0. Learners' active communication and participation in communities via social networks are the foundation for this active learning. They suggested in this scenario, traditional platforms to support teaching and learning - traditional LMSs - should be replaced by other architectures where learners are also able to handle daily basic communication and interaction in formal or informal, and even playful ways. This suggestion refers to the recent emersion of social network services (SNSs) as a potential teaching and learning environment in the field of education. However, most of the popular SNSs in existence are not designed for the purpose of teaching and learning. A combination of a traditional LMS base with a social network environment should be a significant architectural development to promote learners' active learning. This study examines how elements from two different systems (traditional LMS and SNS) integrate together to facilitate collaborative learning in a novel LMS design for shared cognition.

Enhancing learners' collaborative performance in an online learning environment is a challenging task in education, and as such it has received a great deal of attention over the last few years due to the powerful development of social network applications. Among conventional holistic methods, cognitive research is a direction which gets many notable results in collaborative learning. However, there are, to the best knowledge of the authors, no virtual learning environments which directly support shared cognition in order to activate group metacognition. The think-aloud protocol is believed to be able to reveal the underlying thinking activities which are happening in working memory through collected verbal data

(Schellings, van Hout-Wolters, Veenman, & Meijer, 2013). In prior research, think-aloud has been indicated to activate metacognitive monitoring in students. However, the question about how to enhance learners' collaborative performance by cooperating through the think-aloud protocol in an online learning environment is still open, especially in a social learning context. This study focuses on the think-aloud tool and how it enhances collaborative performance through sharing cognition in a social LMS.

Review of related literature

The trend of using SNS as learning environment and its constraints in education

Many studies have been conducted to examine SNS's usages and advantages in education. Dabbagh and Kitsantas (2012) suggested that social media tools could be used to create a personal learning environment (PLE) for the development of formal and informal learning spaces which enable individual knowledge management and construction. DeAndrea, Ellison, LaRose, Steinfield, and Fiore (2012) found mediated interactions with others on a student-centered online social media site might ease students' self-efficacy beliefs which affect students' perception of college life and their adjustment to college. Arnold and Paulus (2010) considered SNS as an online hub to denote that SNS provides students the chance to post publicly, model approaches to assignments, exchange feedback, and connect to the work of others.

Among the research on SNS in education, studies regarding college student use of Facebook seems to get the most attention (Ellison, Steinfield, & Lampe, 2007; Kabilan, Ahmad, & Abidin, 2010; Pempek, Yermolayeva, & Calvert, 2009; Roblyer, McDaniel, Webb, Herman, & Witty, 2010; Valenzuela, Park, & Kee, 2009). This

trend can be explained by the high number of online users on Facebook. With its popularity, Facebook has become the unofficial representative for the trends of using SNS as a virtual learning environment. Although being considered to have the potential for education, constraints of popular SNSs in education are being increasingly reported. Research results from a survey on Facebook usage among undergraduate students stated that students do not think of Facebook as a medium for formal teaching purposes, but they mostly think of Facebook for social reasons (Madge, Meek, Wellens, & Hooley, 2009). The research also indicated that time spent on Facebook made students distracted from schoolwork. The attitudes of teachers and students concerning their use of SNS as learning tools are another topic for research. It has been reported that teachers, when compared to the opinions of students, view Facebook as having less potential in learning (Roblyer et al., 2010). This can be explained by the fact that most of popular SNSs are strongly designed for social interaction which is what students want, but by not being designed for education purposes can cause teachers to feel as though they do not have enough tools for managing learning activity on popular SNSs.

In contrast, application of serious SNSs which concentrate in education is receiving high attention from researchers. Edmodo and Schoology are representatives for learning-oriented SNSs. Balasubramanian, Jaykumar, and Fukey (2014) discussed from a study on Edmodo as a learning platform that Edmodo can bring up the combined knowledge creation of a group better than individual discussions. Manning et al. (2011) suggested Schoology can help teachers meet literacy goals by keeping relevant the ways teachers teach and the ways students are expected to learn. In addition, DeAndrea et al. (2012) reported a serious SNS in their research makes students improve their self-belief that affects the students' perception and leads to their adjustment to college. Research results on serious SNSs show that there are needs of SNSs that are tailored for teaching and learning environment.

The current issues of the existing LMSs

Issues in design of the traditional LMSs

Although many e-learning approaches as stand-alone applications or as a part of an integrated LMS have gained varying degrees of success, the common lack of a supportive environment for helpful interaction and communication among users reduces the educational effectiveness of these approaches. For instance, a low degree of interaction in text-based traditional approaches such as forums, wikis, and blogs can make these approaches become tedious. Reading from page to page on a computer screen without any interaction can be fatiguing and stressful to learners. An uninteresting interface between the learner and learning materials can cause the learning process to become boring and further cause diminished learning motivation (Curtis & Lawson, 2001). The lack of historicity management ability is another common issue with most LMSs. Learners can be restricted in their ability to organize information and relevant contents if they cannot trace the history of the information used during their learning process.

The initial intention of LMS design is to provide a flexible framework for innovative learning pedagogies. However, research showed that current exiting LMSs emphasize faculty dissemination tools over student learning tools. But the fact is that as a student learning tool LMSs are more likely to promote student engagement and interaction (Dewiyanti, Brand-Gruwel, Jochems, & Broers, 2007; Liaw, Chen, & Huang, 2008; Scardamalia & Bereiter, 1994). Deploying LMSs in educational institution is always under the control of faculty and administration board. As a result, LMSs have been used for the intention of the institution. Learners can feel there is little space for them to manage and maintain their learning activities as well as connect to peers and social networks across time and space. Learners need a personal learning space that is tailored to their activities (Martins et al., 2012; Van Harmelen, 2006).

In addition, the learning resources for learners available on an LMS used in a

particular course are often organized as time-limited access. After the course is over, relevant material like course data, learners' contacts, and learners' peer connections are also over or cannot be accessed again due to restrictions to time, privileges, or access methods which are inherent in the LMS.

Transformation into a social LMS

It can be seen that traditional LMSs are transforming to adapt to social environments. Not long ago, some remarkable functions have been integrated into popular LMSs, such as forums, chatting, and wikis so as to be mentioned as the social interaction ability of LMSs. Although these functions have certain effects for exchanging communication e.g., function of forum and chatting, and collaborative working e.g., function of wiki, these are not enough for a social interaction environment. Social interactive activity occurs in more natural ways. It is not limited to a predetermined topic used in forums, short exchanging using instant messages when chatting, or anonymous collaboration as with wikis. Even more, social interactive activity is not bound to only text messaging.

In recent years, some prominent social oriented LMSs have appeared, such as Edmodo[1] and Schoology[2]. Edmodo is an academic network in the form of a social network sites. Because its interface is similar to Facebook, it is commonly referred to as the "Facebook" of higher education. The specific subjects which Edmodo serves are teachers, students, parents, schools, and districts. There are some studies on the role of Edmodo as a learning environment. Gushiken (2013) organized an instructional design module as a guide on how to integrate Edmodo to promote interactive online communication. Although concluding that it is necessary to use this tool in students' collaborative work, Gushiken needed to use several other tools to make his learning module in Edmodo. Balasubramanian et al. (2014) used Edmodo for RASE (Resources, Activities, Support, and Evaluation)

1) https://www.edmodo.com
2) https://www.schoology.com

pedagogical model to study student preferences in using Edmodo as learning platform. Their findings informed that students strongly agree with using Edmodo to create a responsible learning environment. However, the study also indicates Edmodo is much more private than popular social network sites. Learning groups on Edmodo can only be accessed by students who are already registered to a group or have an access code from the site manager. This can reduce the user's level of comfort and negatively affect their willingness to share information when working on the system.

Similar to Edmodo, Schoology offers an LMS with a social media option ("Schoology Offers LMS and Social Media Option," 2011). Research shows that quizzes, test modules, and ability to post content are the most appealing features of Shoology for teachers. The ability of import and export data for users, courses, and grades as well as the ability of permission control is a benefit for administrators. However, there was no mention concerning student satisfaction.

Collaborative learning on an online learning environment

Collaborative learning (CL) and team-based learning (TBL) refer to an instructional method in which students at various performance levels work together in small groups toward a common goal. CL focuses on the responsibility of students in helping other students as well as their own learning progress. The success of a student, in the end, depends on the success of a working team. Computer-supported collaborative learning (CSCL) is a common topic which has been covered in many studies. CSCL is a pedagogical method in which the learning activity takes place via social interaction using a computer or through the Internet. CSCL is studied in many approaches, from general use (Stahl, Koschmann, & Suthers, 2006) to analysis of elements of CL (Laal, 2013a), motivations of learners to use CSCL (Schoor & Bannert, 2011), and CL in online environments (Curtis & Lawson, 2001; Liaw et al., 2008).

Online learning environments can be considered as a context for CL where information technology and network technology facilitate the interactions among learners for acquisition and sharing knowledge. Scardamalia and Bereiter (1994) argued that web-based collaborative environments provides a vital kind of support to engage learners in collaborative knowledge-building. This can be achieved because the online collaborative environments provide equal opportunities for learners to participate without a limitation on knowledge levels. Dewiyanti et al. (2007) recommended the application of an asynchronous environment as a medium to support CL for distance education because CL can be noticed as a didactical approach that stimulates "new learning". Liaw et al. (2008) proposed an acceptance model for web-based CL based on learners' attitudes toward Web-based collaborative learning systems. According to that study, if the quality of the system's collaborative learning environments was improved for group work, it may increase learners' cognitive perceptions, and highly cognitive perceptions may enforce learners' intentions to use web-based collaborative learning systems.

Interaction among learners is one of the most important factors for making a positive contribution to a learner's CL. However, the interactions of learners on online learning environments are mediated by a medium (Curtis & Lawson, 2001). The limitations of currently existing mediums restrict learner interaction to text only messages on the screen. On screen text messaging and the lack of verbal cues cannot fully convey the meaning of rich contextual interactions, which may reduce the degree of learner CL.

Think aloud and teaching and learning metacognitive activities

Thinking aloud is a favorite strategy which is often used to teach and assess metacognitive activities in educational research (Azevedo, 2005; Bannert & Mengelkamp, 2008; Hofer, 2004). It is a method that requires learners to audibly verbalize what they are thinking about while they are solving a problem of

performing a task (Ericsson & Simon, 1980; Veenman, Elshout, & Groen, 1993; Young, 2009). The think-aloud protocol is believed to be able to reveal the underlying thinking activities which are happening in working memory through collected verbal data (Schellings et al., 2013). Jaspers, Steen, Bos, and Geenen (2004) argued that the think-aloud method is a unique source of information on cognitive processes. The think-aloud method offers very direct insight as to how a person solves problems. The protocol is assumed fairly reliable because the thinking aloud activity happens almost simultaneously with every small step of thinking process. Ward and Traweek (1994) indicated that think-aloud also activates metacognitive monitoring in students whose self-regulation has not yet become automatized. Research reported that the protocol resulting from online thinking aloud methods may be less distorted by interpretations, expectations and memory errors of participants when comparing with retrospectives reports (Schellings et al., 2013). Although it is widely accepted that think-aloud is important in cognitive research, the need for valid and effective tools to facilitate the protocol in teaching and learning still remain strong.

Method

Research target of this study is a sharing cognition LMS in the form of a social network site as a novel teaching and learning environment. It named YOTBook, designed and developed for 8 months in the Education Technology Lab of Chonnam National University, Korea. It stands for "Your own thinking book", which is expected to be a place for learners to share their own thinking processes.

Developmental research Type II: Design & Development (Richey, Klein, & Nelson, 2004) was employed in this study. It conducted an in-depth examination of the design of the research system in order to clarify elements supporting the improvement of collaborative performances. The study was oriented toward

studying the design and development process of the research system and made an effort to identify, describe, and explain conditions that facilitate successful research system. The research procedures were as follows: (1) to examine the principles and theories such as constructivism in learning, collaborative learning, cognitive theories, and web-based learning, (2) to analyze educational functions of other related systems such as LMSs, SNSs, (3) to model a research model for designing product, (4) to develop the research product, (5) to demonstrate a pilot instructional design in order to try to explain usage of elements in the research system.

Results

Modeling the research model and designing the research system

According to studying and analysis of principles, theories and related literature regarding design and develop collaborative learning, constructivist learning, web-based learning, think-aloud protocol, as well as analysis of other related systems, the research model is depicted as Figure 1. It consisted of 3 basic theoretical elements as follows: think-aloud element, social network element, LMS element. Learners work directly with think-aloud element as the most inner component of the system to share their verbal cognition whereas social network element connects individual as personal connection to support collaborative working. LMS element is the base component for whole system and works almost transparent to learners but it manages and aids learning activities of the learners on the system.

Based-on the research model, YOTBook was designed as the research system. The design of YOTBook facilitates the relationship of learners in a social environment. People can join YOTBook and act as an individual or as a member of a group. YOTBook maintains the social relationships between people when they

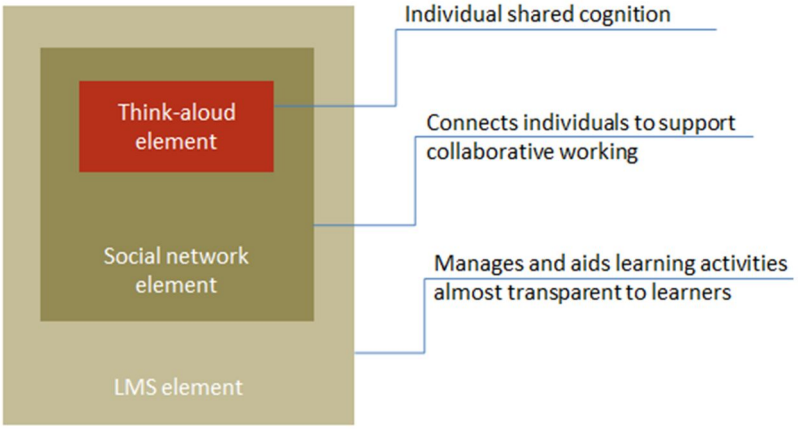

Figure 1. Research model as a united system

participate in the system. The design of the LMS in a form of a social network environment is expected to facilitate the social nature of learning. Learners study on YOTBook, spread what they have learned to their friends, and then they learn from what others shared with them. Cognition process sharing during the time learners are solving problems can also be enable in this design. With the integration of a think-aloud component, learners can record their verbal thinking while typing, or listening to what their friends were thinking about while reading their friends' feedback. Figure. 2 shows the above environment design.

The three prominent elements of this environment will be discussed in detail in the next section.

Think-aloud element

In YOTBook, the think-aloud element is deployed through a voice recording component integrated in a message exchanging tool. The voice recording component collects think-aloud data. It was designed to automatically record verbal data from learners when they start to type in message box and share that data as learners' thoughts on either their individual page or on a learning topic page which

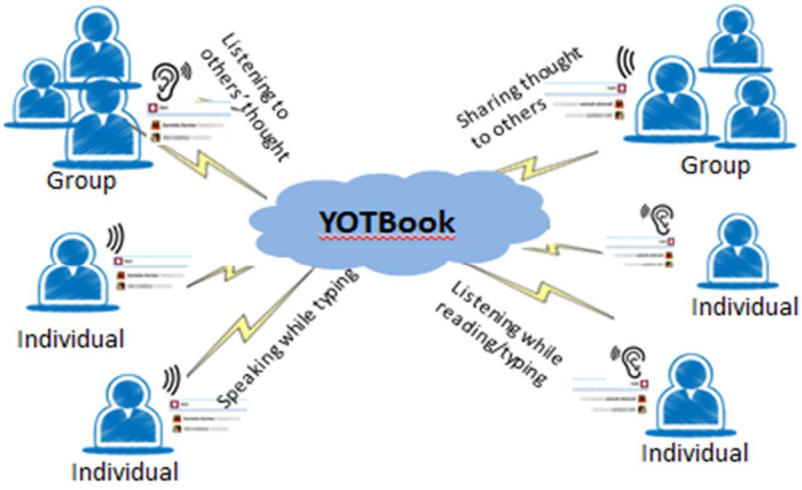

Figure 2. Environment design of the research system

they have joined. This recorded verbal data is considered as concurrent probes to take the advantage of reducing memory failure which may occur when one waits to recall an activity (Young, 2009). The record process can be handled automatically or manually by the learners.

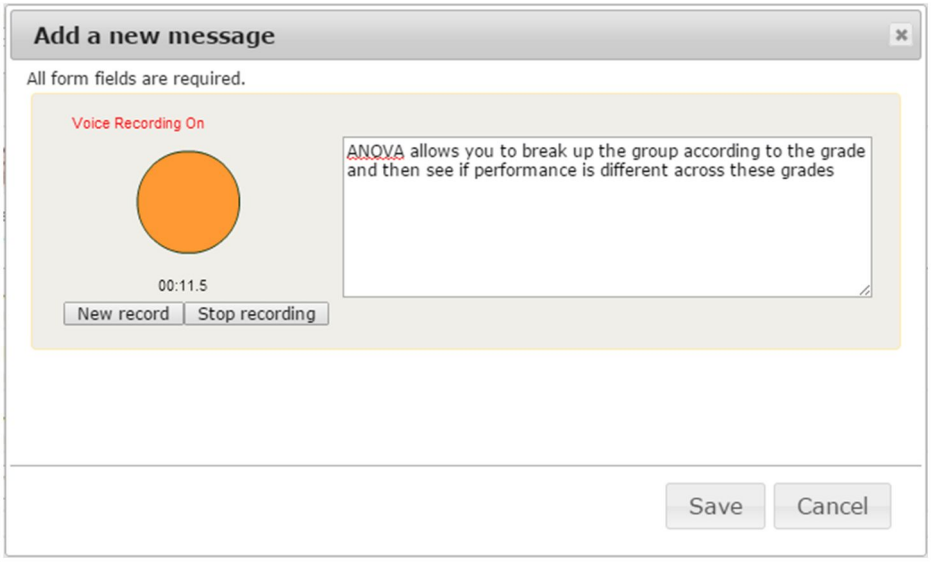

Figure 3. Message exchanging tool for a combined massage

In other studies, think-aloud data are audio or video data which was recorded separately from the works of participants (Baumann & Jones, 1993; Ericsson & Simon, 1980; Jaspers et al., 2004; Wade, 1990). In YOTBook, think-aloud data are recorded and saved along with the works of learners. After learners finish their work, the verbal data and textual data are saved, and then displayed together (Figure 4). This kind of design helps not only learners but also peers in their personal connection can view the shared cognition contents easily. Even teachers and researchers can observe the threads of their students' thoughts in a systematical way.

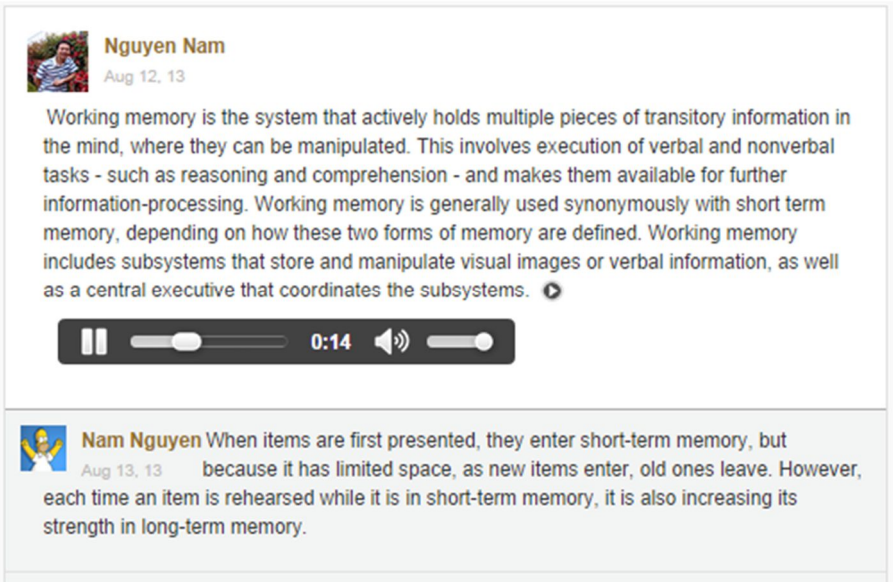

Figure 4. Textual data and verbal data on learner's page

Social network element

The role of the social network element in YOTBook

Every user of a SNS can be an information creator. They can create new information instantly on their pages with their own knowledge, or by synthesizing information from shared sources, or even just by sharing others' information.

Through receiving and sharing information, users can also acquire new knowledge. Thus, SNSs promote knowledge creation and acquisition.

The design of YOTBook as a SNS plays an important role in the learning environment. It is the element that is expected to facilitate learners to acquire and create new knowledge freely, strengthen their natural social relationships via their personal social connections, and improve the quality of their collaborative learning environment.

Information creation on YOTBook is a tightly dependent relationship. YOTBook relies on the relationships between people as its skeleton to maintain learners' social activities in a virtual environment. Figure 5 denotes a basic relationship model between two users. This kind of relationship is similar to a natural relationship in the real life between people. By this way, YOTBook facilitates the creation of its users' personal social network.

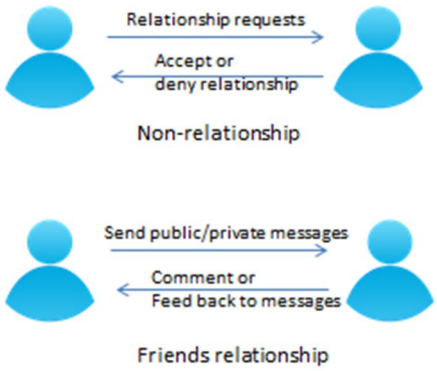

Figure 5. Model of non-relationship and friends relationship on YOTBook

As a personal social network is formed, collaborative settings can be easily performed. With the openness of the research system, 3 ways of group work and CL and most of basic elements in CL (Laal, 2013b) can be satisfied.

The design of the social network element

A learner's profile is an important part of the system's social network element. It

is not only a means for people to find each other, but it also assists the system to extend its activities. The research system has a capability of recommending useful information to users based on users' profile information. This type of information can help learners quickly catch attractive information without having to search around the system. Tag cloud is also one part of this kind of information to recommend the most popular topics is organized as a tag cloud.

The social connection element also includes making and maintaining a personal social network as well as performing social communication and interaction via a virtual environment. Although social media is debated as just a variation on what is fundamentally people communicating with people (Ravenscroft, Warburton, Hatzipanagos, & Conole, 2012), social connection still plays as one of the key points to distribute learning activities in a learner's personal social network (Dabbagh & Kitsantas, 2012). The purpose of connecting people in YOTBook is to make the quality of the collaborative environment better for sharing cognition in teaching and learning activities.

Sharing learning activities as well as learning contents on YOTBook is driven by the smallest unit of the system – friend relationship. It decides how people can see the activities of others. But it does not mean that if I am in a "friend relationship" I can see all my friend's activities. Sharing privileges is another barrier for sharing activities. Activities can only be shared to people in "friend relationship" when the owner of the activities gives approval to share. The diagram in Figure 6 demonstrates how content can be shared based on sharing privileges. By this way, the system can guarantee the privacy of a learner on YOTBook in order to encourage the learner in generating as much content as desired.

The design of sharing content in this way gives leaners more autonomy to their contents. As a result, it can help to raise the learner's self-responsibility to their activities on a virtual social environment. Leaners now are given maximum freedom on their hands to control what contents can be shared to others. The control over content of the learner is now independent from the system, which constitutes a

natural social environment. Therefore, it opens a chance for collaborative working in both a private mode and a public mode.

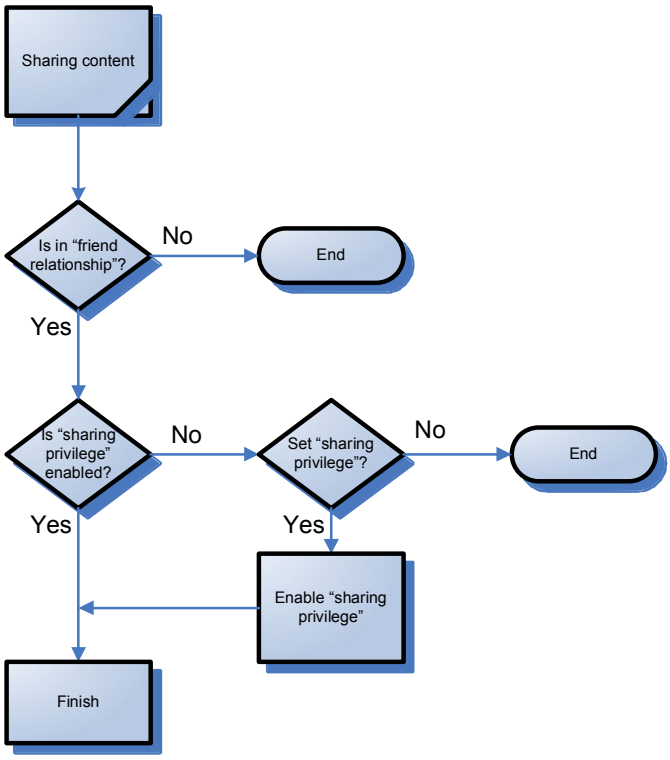

Figure 6. Diagram of sharing content protocol

Learner space is another part of the social network element. It is the page where the learner's activities and members in their personal social connection are shown. Depending on accessing context, information on the system is organized differently for learners. Typically the first impression of learners when looking at the interface of the learner space is that it feels somewhat similar to Facebook. There are some purposes for this kind of design. Firstly, creating a sense of familiarity among the users of YOTBook is important for first time experiences, and since most college students have a Facebook account, that design was used as a benchmark. Secondly, ensuring that the interface is user-friendly can help to maintain the retention of

users in the system for a long time.

Learning management element

Learning space

Learning space is the most important part of the learning management element. Learning space in the research system can be seen as a space where learning activity and learning management activities happen. It includes a private space and a collaborative space. Learning space was designed based on analyzing the flow of a learner's activity on the social network environment (Figure 7). When a learner logs into the system, the learner can choose to work in a private space or in a collaborative space. The private space refers to the individual activities of the learner. Activities, likes changing their status, updating their personal profile, visiting a friend's page, giving comments to a friend's activities, organizing contents on their personal page, checking personal learning progress, and taking notes, are referred to as individual activities.

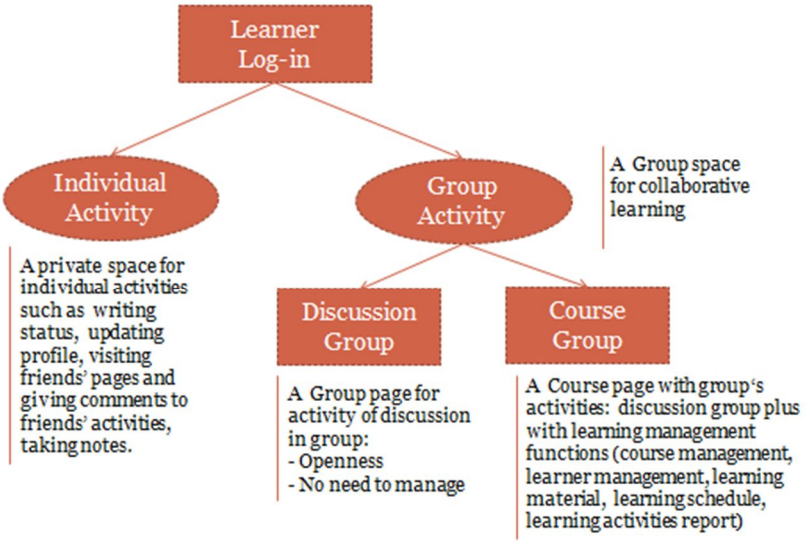

Figure 7. Analysis flow of learner's activity

In collaborative learning activities, YOTBook provides two group activity forms to learners. The first form is a familiar group activity which is used popularly on most of SNSs, group discussion (or topic discussion). The aim of this group discussion is to be a space for open discussion among group members. It does not require any management activity. Everybody in this discuss group is equal. It would be suitable for collaborative work which does not require progress management.

Another group activity form is course group. This is the form that fully supports collaborative learning. Although it can be considered a combination of discussion group with learning management functions, its applicability is greater than that. Besides the advantage of acting as a topic-oriented discussion group, a whole collaborative learning course can be implemented on this form. To facilitate teaching and learning activities, a rank of learning management functions, such as course and learning content management, learner management, learning schedule, and learning activities report, can be found in this group activity form.

The research system treats every account in the system equally. It does not require users to verify their role as a teacher or learner before starting to work on the system because a user's role should not be placed in a pigeonhole at the time of registration. Individuals have flexibility in how they want to participate in this system. Being aware the above fact, YOTBook allows users to have many roles. This means learners can use the full function which the system provides. Restricting user's role is only implemented at the course level, and not implemented at the system level. A particular course distinguishes three roles of users: course's owner (usually the teacher of the course), course's co-owner (usually is an administrator or editor of the course), and leaner. Depending on the role of the current log-in user, the system will display proper functions on the learning space. For example, an owner can edit the course and manage the course; a co-owner can edit or add more content; the learner can comment, evaluate, and invite friends.

Learners' collaborative learning with think aloud activity

To demonstrate collaborative learning activity in the research system, a pilot

course designed with constructivist problem-based method was implemented with a small group of 7 volunteers. The fully collaborative learning activity was performed in the course group space. The course group page organizes learning contents as well as learning activities on the same page (Figure 8) but being divided as several learning problems or learning topics. Each learning topic works as a container for learning materials. This container holds several learning materials. There is a main content per learning topic. This main content is an auto-play content. It automatically plays whenever the learner opens the learning topic which holds this content. The main content is supported in video format, and every document format is converted to a picture via flash format. Other learning materials can be considered as support contents. Support contents can be added in all file types. Each learning material has description information and rating information. Teacher used the description information as instructional information for each learning material. After learning each material, learners rated learning content based on the learner's satisfaction to the learning content. To organize learning materials tightly in a limited amount of space and make learners concentrate on the current learning topic, every learning material container is designed as a collapsible content panel which can show or hide its content whenever it is clicked on.

During the learning process, learners were requested to think aloud the problem showed on the learning topic. The think-aloud element is integrated in the message exchanging tool recorded learners' cognition as verbal data at the time they are solving problems. If the think-aloud cannot detect learners' voice, it automatically pauses and push out a message to remind learners to continue or not. The SNS environment of the research system supports learners' communication, and distributes not only learning materials but also their thinking process to each other.

Learners' think-aloud activities were recorded automatically and shown back in the communication thread of group members in a time-based order. In this way, members of a group could observe how a member thought to solve a particular problem at a specific time. This cognition sharing process is useful for the mutual

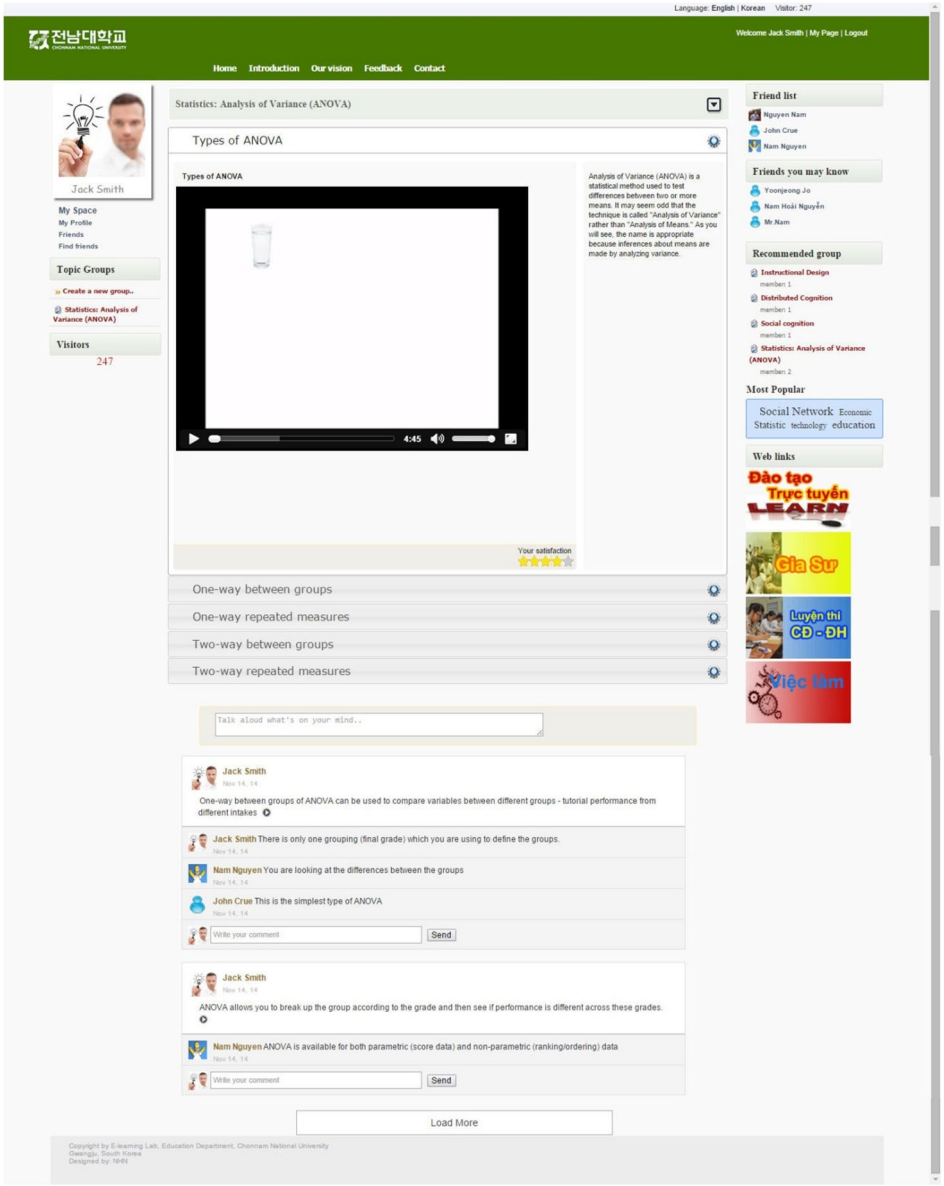

Figure 8. A sample learning course with the collaborative activity of learners

support of group members to collectively achieve the targets of a lesson. Teachers of the course could know more clearly how learners thought as they try to solve a problem. Teachers also could track the communication threads of learners in a

group in order to investigate how learners collaborate, and recognize the extent to which their communication was congruous. Based on the investigated information, teachers could have suitable solutions to orient group activities for developing more efficient and effective collaborative performances. The amounts of time to collect and organize think-aloud data is said to reduce dramatically but it still needed efforts to validate these data.

Application suggestion

Forming a new learning environment

Forming a novel learning environment is the first application that can be seen from the system point of view. It is the social network element that helps the system to form a social learning environment. The social network element is the foundation that makes this system transform into a social LMS.

Attitude and satisfaction levels of learners are indicated as two important factors to keep learners using a system (Liaw et al., 2008). Joining and maintaining a personal social connection in the study system does not require an unreasonable amount of personal information and effort from the users of the system. However, information in the system still gets updated with the users continued activity. The capable of synthesizing user activities as well as user behaviors keeps information always new every time users logging in. It might help to build a good attitude and gain satisfaction from learners so that it can encourage learners to use the system more frequently. Learning activity in the system occurs normally as a social activity and this activity is updated and expanded throughout the personal social network. This natural flow of activity might make learning activities more exciting. Imagine that the performance and learning progress can spread and be shared with others in a natural way, this could motivate learners to become more active participates in

learning activities on the system.

Social relationship among learners or between learners and teachers in the system is strengthened by several social tools. Learners now are encouraged to express their thoughts and converse with each other more. In addition, even at the time a course, learners' learning materials, learning progresses, and personal connections with others still stay in the system. Learners still can observe activities of others even though they may not have been in contact with each other for a long time. It keeps learners' information relevant with the content creator and its purpose.

Teaching and learning shared cognition tasks

It is the think-aloud element that facilitates the teaching and learning of shared cognition tasks on the study system. Teachers can organize learning courses using the LMS element and require learners to talk aloud about what they are thinking while resolving learning problems. Learners perform the requirement in the course. Learners' cognition processes are recorded as verbal data along with the results of their solving problem process.

Results come from the process of solving problems are now available in not only simple text-based data but also audio-based records of a learner's cognition processes. The cognition processes come from directly concurrent thinking processes of learners, meaning that this data is more reliable than retrospective data because it reduces error caused by memory errors and reduces data distortion.

Teacher's analysis of learner cognition is now more convenient. The teachers can monitor learners' data by threads in the order of time. Teachers can choose to observe learners' tasks on their pages, on the teacher's own page, or on the course page. The system gives the teachers a chance to have a collective view of all learners' activities in the course, or just only activities of a particular learner. This way, teachers can catch the context where an activity happens to have a better understanding about the activity. Likewise, learners can also check again the process

in which they performed the learning task. Reviewing again what happened can help learners self-regulate their learning activities for better performance in future tasks.

Collaborative learning environment for shared cognition tasks

The capability of organizing a learning course into groups of LMS elements allows the system to provide a collaborative learning environment. The social network element spreads learning activities and the social interactions of learners to the whole personal social network of learners. In other words, the quality of the collaborative learning environment is improved by the social network element. According to the acceptance model promoted by Liaw et al. (2008), improving the quality of collaborative learning environments may increase learners' cognitive perceptions. In turn, highly cognitive perceptions may enforce learners' intentions to continue staying in the systems.

Moreover, the combination with social network elements of the system makes learners' cognition processes spread to not only teachers of the course but also to other members of the course. But it is not a one-time process of spreading the learners' cognition processes. The more time the learners are working on the course, the more cognitive sharing occurs with other course members. It is the distribution of cognition over the learner's personal social network that enhances the learning experience of all. Through the distribution of cognition, members of a group can know the way each member works on the learning task. In this way, they can help each other to address problems, find solutions, and make group performance become better.

Discussion

Enhancing learners' collaborative learning performance on an online learning

environment is the concern of this study. The motivation for this study comes from the trends of using SNS as an online learning environment, the lack of supportive environment for helpful interaction and communication among learners of existing LMSs, the limitation in text-based interaction of existing collaborative learning methods on online learning environments, and the needs to have a better tool for sharing learners' cognitive processes. The study is expected to contribute to the knowledge of collaborative learning on an online learning environment. As a novel design for an LMS with shared cognition, this form of a social LMS is an alternative approach for enhancing group collaborative learning performances.

In this study, the design of three critical elements of the study system was analyzed. Also, three directions by the combination of the three critical elements were applied to the study system in an educational context. Social LMS with the combination of social network elements and learning management elements was the first application. The addition of the think-aloud element to the learning management element is expected to support teaching and learning via shared cognition tasks. To improve collaborative learning performance in an online learning environment, the cooperation of three above critical elements is supposed to gain effectiveness. In addition, the process of spreading cognitive processes among personal social connections on the study system is the process of cognition distribution.

Although the system has not been tested empirically with a large amounts of users, it is postulated that as learners engage in a personalized-oriented learning system with rich connectivity and the help of instructors and other members of a group on their sharing cognition, they are expected to become motivated and empowered to achieve the desired learning outcomes and enrich their learning experience.

Validation of think-aloud data is another issue that needs further study to improve the effectiveness of the system. At this time, the validation procedure still relies on efforts of teachers.

A limitation of the current research is that the study relies on tentative applications of the system design which cannot predict the critical use of students. Although the system was carefully designed based on learning theories, it needs the intensively long usage of users to reveal how many ways users actually work on the system. Moreover, perceptions of users about group works on the systems and their styles of use might vary differently from the intention of the designer so that collaborative performance might also be varied. An empirical research with large size of samples and long observation time needs to be carried out to clarify the above issues.

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