บทความวิจัย

การพัฒนารูปแบบการแลกเปลี่ยนเรียนรู้โดยใช้คอมพิวเตอร์สนับสนุนการเรียนรู้แบบร่วมมือตามแนวคิดการเรียนรู้แบบเพื่อนช่วยเพื่อนเพื่อส่งเสริมพฤติกรรมการสร้างความรู้ของนิสิตนักศึกษาระดับบัณฑิตศึกษา

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บทคัดย่อ

การวิจัยครั้งนี้ มีวัตถุประสงค์เพื่อพัฒนากระบวนการแลกเปลี่ยนเรียนรู้โดยใช้คอมพิวเตอร์สนับสนุนการเรียนรู้แบบร่วมมือตามแนวคิดการเรียนรู้แบบเพื่อนช่วยเพื่อน เพื่อส่งเสริมพฤติกรรมการสร้างความรู้ของนิสิตนักศึกษาระดับบัณฑิตศึกษา การดำเนินการวิจัยและพัฒนาครั้งนี้ศึกษาผลการใช้งานกระบวนการแลกเปลี่ยนเรียนรู้กับนิสิตระดับบัณฑิตศึกษา จำนวน 25 คน ซึ่งได้มาจากการเลือกแบบเจาะจงที่ลงทะเบียนเรียนในภาคเรียนที่ 1 ปีการศึกษา 2551 สาขาวิชาเทคโนโลยีและสื่อสารการศึกษา คณะครุศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย เป็นเวลา 16 สัปดาห์ เครื่องมือที่ใช้ในการวิจัย ได้แก่ โปรแกรมคอมพิวเตอร์สนับสนุนการเรียนรู้แบบร่วมมือ แบบวัดพฤติกรรมการสร้างความรู้ แบบประเมินผลงาน แบบบันทึกการทบทวนหลังการปฏิบัติกิจกรรม แบบบันทึกการสังเกตพฤติกรรม และแบบบันทึกการสัมภาษณ์ความคิดเห็น ผลการวิจัยพบว่า องค์ประกอบของกระบวนการแลกเปลี่ยนเรียนรู้ ประกอบด้วย บุคคล สาระความรู้ เครื่องมือคอมพิวเตอร์สนับสนุนการเรียนรู้แบบร่วมมือ การปรับเปลี่ยนและการจัดการพฤติกรรม และการประเมิน ส่วนขั้นตอนของกระบวนการแลกเปลี่ยนเรียนรู้ ประกอบด้วย 1) ขั้นแนะนำแนวทาง สร้างกลุ่มสัมพันธ์ 2) ขั้นกำหนดความรู้ นำไปสู่เป้าหมาย 3) ขั้นสืบเสาะแสวงหา เพื่อพัฒนาผลงาน 4) ขั้นพบปะแลกเปลี่ยน เพื่อนเรียนเพื่อนรู้ 5) ขั้นสร้างสรรค์เผยแพร่ ร่วมแก้ร่วมปรับ และ 6) ขั้นประเมินผลงาน ผลานความคิด ด้านพฤติกรรมการสร้างความรู้ของกลุ่มตัวอย่างหลังการทดลองสูงกว่าก่อนการทดลอง อย่างมีนัยสำคัญทางสถิติที่ระดับ .05 และผลการวิเคราะห์คะแนนการประเมินผลงานของกลุ่มตัวอย่าง พบว่า อยู่ในระดับดี

คำสำคัญ: การเรียนรู้แบบเพื่อนช่วยเพื่อน, การแลกเปลี่ยนเรียนรู้, คอมพิวเตอร์สนันสนุนการเรียนรู้แบบร่วมมือ, พฤติกรรมการสร้างความรู้

RESEARCH ARTICLE

Development of a Knowledge-Sharing Model using CSCL based on a PAL Approach to Enhance Knowledge-Creation Behaviors of Graduate Students

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Abstract

The purpose of this research was to develop a knowledge-sharing model by using computer-supported collaborative learning (CSCL), based on a peer-assisted learning (PAL) approach, to enhance knowledge-creation behaviors of graduate students. In this research and development (R&D) dissertation, the knowledge-sharing model was implemented by twenty-five graduate students who were selected by a purposive sampling method. They enrolled during the first semester of the 2008 academic year in the field of Educational Communications and Technology at the Faculty of Education, Chulalongkorn University for sixteen weeks. The research instruments were a CSCL application program, a knowledge-creation behaviors check-list, a product evaluation form, an after action review form, a behaviors observation record form and an individual interview record form. The research findings indicated that the five components of a knowledge-sharing model were: people, content, computer-supported collaborative tools (CSCT), transition and behavior management and evaluation. The six steps of the knowledge-sharing processes were: 1) orientation and group socialization; 2) knowledge identification to reach goal; 3) knowledge acquisition to develop product; 4) knowledge sharing and peer meetings; 5) knowledge creation and revision; and 6) product evaluation and idea integration. There were significant differences in pretest and posttest scores for knowledge-creation behaviors at the .05 level of significance. The overall product outcomes developed by the learners were at a satisfactory level.

Keywords: computer-supported collaborative learning, knowledge creation behaviors, knowledge sharing, peer-assisted learning

Introduction

In recent years, having applied in theory of knowledge management (KM) to education educators, educators from many countries found that knowledge in their organization could be effectively shared among their members. (Kidwell et al., 2001; Milam, 2001; Thorn, 2001) Also, it is universally accepted that KM has become a necessity to improve the use of information systems and to create participation in data transfer.

This research has tried to apply the concept of KM, which consists of basic processes including creation, storage/retrieval, transfer and application (Alavi and Leidner, 2001), in the modeling and development of a knowledge-sharing process for graduate learners, in combination with peer-assisted learning and 'learning before doing' through others' experience (Collison and Parcell, 2001). Knowledge management projects are attempts to do something useful with knowledge to accomplish organizational objectives through the structuring of people, technology, and content (Davenport et al., 1998). This study tried to have knowledgeable, skilled and experienced people interact amongst themselves to share knowledge, skills, and experiences in a specific area. The role of the instructor was to give suggestions and facilitate the learning process.

Computer-supported collaborative learning (CSCL) (Wana and Hsiao, 1997; Lipponen et al., 2004) is one of the most important KM practices. Knowledge-sharing is done with the help of computers followed the principles of the Knowledge Spiral or The SECI model (Nonaka and Takeuchi, 1995) which proposed that organizational knowledge is created through the continuous social interaction of tacit and explicit knowledge involving four sequential modes of knowledge conversion: socialization, externalization, combination, and internalization. A knowledge conversion program was developed according to the Assistant Computer Theory to support joint learning. A CSCL application program for a knowledge-sharing model, based on a PAL approach to enhance knowledge-creation behaviors, is in the form of simple templates or wizards allowing learners to think, question, find, convert, and record knowledge by choosing tools which are suitable to each individual. The learners could thus communicate as much as they like, with no limitation.

Moreover, the proposed approach should motivate learners to seek more knowledge. They could share and expand their knowledge in group conversations in order to produce insightful knowledge outcomes. Educational innovations should enable higher education learners to meet their learning goals according to the national education reform plan (Commission on Higher Education, 2005).

This study was conducted to develop a knowledge-sharing model using CSCL based on a PAL approach to enhance knowledge-creation behaviors of graduate students.

Purpose of the Research

To develop a knowledge-sharing model using CSCL based on a PAL approach to enhance knowledge-creation behaviors of graduate students.

More specifically, the focus of the research is:

1) to investigate the experts' opinion about a knowledge-sharing model using CSCL based on a PAL approach to enhance knowledge-creation behaviors of graduate students.

2) to develop a prototype of a knowledge-sharing model using CSCL based on a PAL approach

to enhance knowledge-creation behaviors of graduate students.

3) to study the effectiveness of a knowledge-sharing model using CSCL based on a PAL approach to enhance knowledge-creation behaviors of graduate students.

Conceptual Framework

The conceptual framework of this research is shown in Figure 1. Five components were involved in order to develop the knowledge-sharing model using CSCL based on a PAL approach to enhance knowledge-creation behaviors of graduate students.

The details of each component are described as follows:

1) Knowledge-sharing is the exchange of experience, knowledge and thoughts between people and groups of people via communication, instructions, seminars, meetings and debates on points of mutual interest, and the transfer of this information in writing in different kinds of printed matter or in virtual reality through the computer network and e-learning (Marquardt, 1996; Kidwell et al., 2001; Milam, 2001; Thorn, 2001). Knowledge-sharing can be either formal or informal; it reduces redundancy and time for finding new knowledge. In addition, if best practice methods are used for knowledge conversion, and there are reliable data, efficient data storing system, and easily accessible data banks, knowledge can be quickly retrieved for problem-solving.

2) Computer-supported collaborative learning is an emerging paradigm (Koschmann, 1996) for research in educational technology that focuses on the use of information and communications technology (ICT) as a mediating tool within collaborative methods (e.g. peer learning and tutoring, project- or problem-based learning) of learning. CSCL interest lies on how collaborative learning supported by technology can enhance peer interaction and work in groups, and how collaboration and technology facilitate the sharing and distributing of knowledge and expertise among community members (TELL, 2006). CSCL encourages learners to convert tacit knowledge to explicit knowledge by building a learning environment that

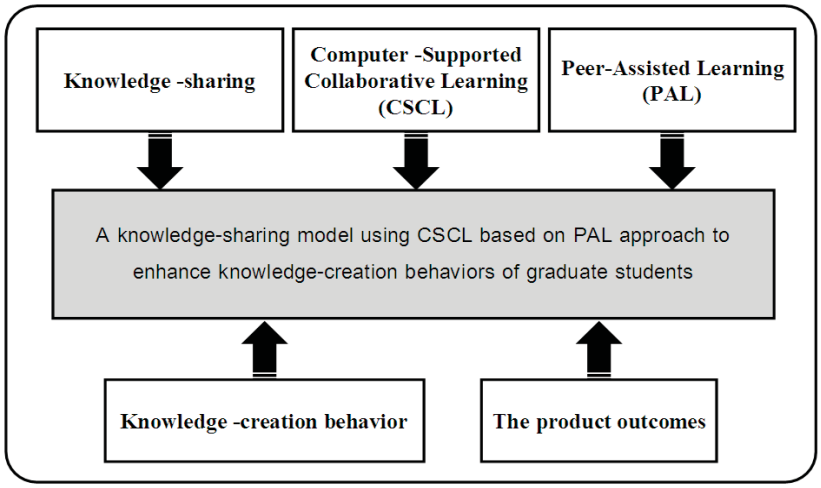

Figure 1: Conceptual framework of the research

enhances learner interaction, knowledge sharing, and opinion and data sharing. Moreover, CSCL aids data storage and searching by relying on computer-mediated communication which may increase the quality of knowledge creation by enabling a forum for constructing and sharing beliefs, for confirming consensual interpretation, and for allowing expression of new idea (Henderson and Sussman 1997).

3) Peer-Assisted Learning is the technique of bringing people together to learn by sharing experiences, insights and knowledge on specific problems, projects or tasks. Learning is achieved through others' experiences, assistance, thoughts, idea and mistakes (Shealagh et al., 2005). Peer assists are a part of a process of what the British Petroleum (BP) Amoco company (1990 cited in Collison and Parcell, 2004) calls 'learning before doing', or in other words, gathering knowledge before embarking on a project or piece of work, or when facing a specific problem or challenge within a piece of work (Collison and Parcell, 2001). The benefits of peer assists are quickly realized when learning is directly focused on a specific task or problem and can be applied immediately.

4) Knowledge-creation behavior is a transforming behavior which explains the creation of knowledge through conversions between tacit and explicit knowledge. Nonaka (1994) proposes that there are four different modes of knowledge conversion according to the Spiral of Knowledge or SECI Model: 1) Socialization: Sharing experiences to create tacit knowledge, such as shared mental models and technical skills; 2) Externalization: The quintessential process of articulating tacit knowledge into explicit concepts through metaphors, analogies, concepts, hypothesis, or models. (Note that when we conceptualize an image, we express its essence mostly in language.); 3) Combination: A process of systemizing concepts into a knowledge system. Individuals exchange and combine knowledge through media, such as documents, meetings, and conversations. Information is reconfigured by such means as sorting, combining, and categorizing; and 4) Internalization: Embodying explicit knowledge into tacit knowledge, closely related to "learning by doing." Normally, knowledge is verbalized or diagrammed into documents or oral stories.

5) The product outcome is a new creation, process of thought and the ability to use knowledge or creative thinking. It may involve the use of a different method or the adaptation of existing conditions to create a new idea that is useful for oneself and the community. The key concept of the product is creation, research and development and technology, which leads to technological innovation. A product need not be new knowledge; it can be existing knowledge, but which involves new thoughts, applications or management methods. Most importantly, it must be useful in a specific area. Products may be achieved by combining existing things to create new and better ones. In this study, when activities are carried out through the process, a product is obtained.

Research Methodology

The study used a research and development (R&D) approach to develop a knowledge-sharing model using CSCL based on a PAL approach to enhance knowledge-creation behaviors of graduate students. The research method consisted of four phases.

Phase 1) Analyzing and synthesizing related literature and documents, investigating the experts'

opinions about components and processes of a knowledge-sharing model. Seven experts were selected by a purposive sampling method. They were presidents and deans in the field of KM and educational communications and technology.The instrument was an in-depth interview schedule, whose content validity had been approved by a research advisor. Its purpose was to capture experts' opinions. After that, the data from the interview was analyzed by means of typological analysis theory.

Phase 2) Developing a prototype of the knowledge-sharing model, based on information from the first phase. The five components were: 1) people; 2) content; 3) computer-supported collaborative tools (CSCT); 4) transition and behavior management; and 5) evaluation. The six steps were: 1) orientation and group socialization; 2) knowledge identification to reach goal; 3) knowledge acquisition to develop product; 4) knowledge sharing and peer meetings; 5) knowledge creation and revision; and 6) product evaluation and idea integration.

The prototype version of the knowledge-sharing model was approved and validated by seven experts in the field of KM and educational communications and technology. They were asked to fill a questionnaire with an Index of Item Objective Congruence (IOC). The results revealed that all items had an IOC greater than or equal to 0.8. Therefore, the prototype of knowledge-sharing model was effective enough to be used in this research. Next, a CSCL application program was developed and approved by a research advisor and validated by the same experts that approved and validated the prototype. The program was tried out with learners who had similar characteristics to the proposed study population and were selected by a purposive sampling method. They were graduate students in department of Educational Technology, Faculty of Education, Silpakorn University, in the academic year of 2007. The try out stage was carried out in order to detect errors and the usability of the program.

Phase 3) Implementing the validated prototype that was developed in the second phase for sixteen weeks to test the efficiency of the knowledge-sharing model. The participants consisted of two groups: Peer-Assisted Group Learners (PAGL) and Peer-Assisted Group Experts (PAGE).

First, the twenty-five graduate students, called Peer-Assisted Group Learners, were selected by a purposive sampling method. The first group of the participants enrolls the design of e-learning course during the first semester of the 2008 academic year in the field of Educational Communications and Technology at the Faculty of Education, Chulalongkorn University. The reasons that participants were selected included: 1) Chulalongkorn University had appropriate facilities for studying the effect of the model; 2) the researcher was granted a permission to collect the data in the organization and many relevant people also cooperated; and 3) the researcher was a Doctor of Philosophy Candidate in the organization. Therefore, the research could be continuously conducted.

Second, Peer-Assisted Group Experts who participated in the sharing of knowledge were selected by a purposive random sampling method. The criteria for selecting the five experts were as follows: 1) they had some connection to that university, such as being former students or current students; 2) they had knowledge and experience about what the peer-assisted group learners needed; or 3) they graduated

from related fields with Master or Doctoral degrees.

The instruments consisted of: 1) a knowledge-creation behaviors check-list; 2) a product evaluation form; 3) an after action review form; 4) a behaviors observation record form; and 5) an individual interview record form.

1) The knowledge-creation behaviors check-list, based on the SECI Model, consisted of four elements: Socialization, Externalization, Combination and Internalization (Nonaka and Tahenchi, 1995; Marquardt, 1996). According to the IOC, the content validity of the check-list was approved by five experts in the field of KM and educational communications and technology. After that, the instrument was tested with thirty graduate students selected by a purposive sampling method. They were graduate students in the department of Educational Technology, the faculty of Education, Silpakorn University in the academic year of 2007. The result showed high reliability of the instrument at coefficient of 0.906.

2) The product evaluation form was to assess three criteria: a product development process, the quality and possibility of the implementation and the innovation of the product developed by the learners. This form was developed from the One School One Innovation (OSOI) project evaluation which was based on the rubrics scale (Bureau of Education Innovation Development, 2006).

3) The after action review form, based on the After Action Review (AAR) technique (David, 2000; Sexton and McConnan, 2003), required learners to evaluate at the end of the activity. There were four items of the evaluation: what did they expect to gain?, what really happened?, If what really happened was different from their expectation, what accounted for the difference?, and what were the suggestions to improve the activity?

4) The researcher conducted the participant's observation by joining the activity and recording the behavior of the participants in the behaviors observation record form. Following were the aspects for the observation: the occurrence of the activity, the behaviors of the participants, and problems or obstacles.

5) The individual interview record form was to record: opinions on each step in the knowledge-sharing process, problems or obstacles and suggestions for improving the knowledge-sharing process. All the instruments had been approved by a research advisor, before the data collecting was conducted.

Phase 4) Revising and proposing a knowledge-sharing model. The researcher employed the data gathered from Phase 3 to revise the prototype. After that, it was presented in a flowchart and descriptive narration to the five experts in the field of KM and educational communications and technology. To evaluate the prototype, they used a rating scale form with five items: 1) the components in a knowledge-sharing model; 2) steps in the process in a knowledge-sharing model; 3) related theories in a knowledge-sharing model; 4) the possibility of the knowledge-sharing process to enhance knowledge-creation behaviors and 5) implementing the knowledge-sharing process in real life situations. Then, the prototype was edited and revised again based on the experts' opinion. Finally, the researcher proposed a developmental knowledge-sharing model using CSCL based on a PAL approach to enhance knowledge-creation behaviors of graduate students.

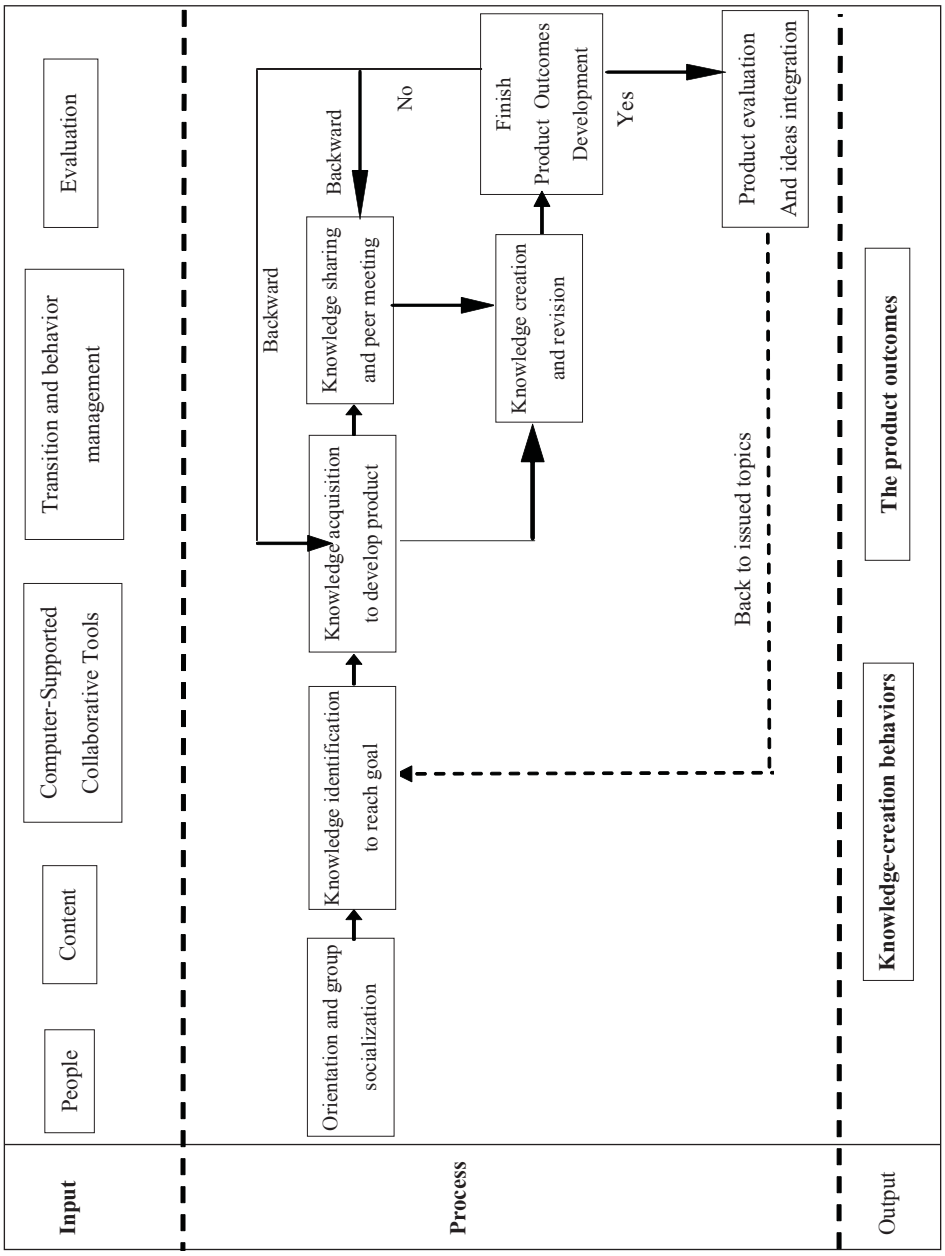

Figure 2: The components and process of a knowledge-sharing model using CSCL based on a PAL approach to enhance knowledge-creation behaviors of graduate students

Research Findings

The results of a knowledge-sharing model using CSCL based on a PAL approach to Enhance knowledge-creation behaviors of graduate students are as follows:

1. The five components of a knowledge-sharing model can be described as follows:

1) People play an important role in creating, storing and sharing knowledge efficiently. They can be classified into course manager, coordinator/ teacher assistant, peer-assisted group expert and peer-assisted group learners. Each of these roles has different desirable qualifications and functions as follows:

1.1) The course manager is the learning facilitator or knowledge navigator who manages activities and encourages, supports and creates a learning environment in order for knowledge-sharing to take place among learners through participation under the individual's needs and interests. The course manager also encourages, motivates, compliments and regularly monitors progress of learners.

1.2) The coordinator or teacher assistant is the person who coordinates participation in activities with the course manager. The coordinator/ teacher assistant is the link between people in the network, procures supplemental data sources and technology, provides advice and suggestions, and solves arising problems.

1.3) The peer-assisted group expert is a person who participates in the sharing of knowledge, skills, expertise, experiences, and opinions and willingly suggests good practices on issues needed or requested by learners in the group. He or she also gives guidance, compliments, and motivation to co-learners regularly.

1.4) The peer-assisted group learners is the group member who participates in the activities in the process. His or her function is to share, find, store, and compile knowledge into sections and system, including analysis and summary, and presenting the knowledge obtained to the group. Moreover, the Peer-Assisted Group Learners uses knowledge gained to develop a product, asking for suggestions or advice from the peer-assisted group expert.

2) Content is skill, experience, wisdom, information or news which is relevant to the topic in question. It can be obtained from people, documents, theories and handbooks. It may be something people gained from knowledge sharing, analysis, synthesis, and extraction of data. Content must be related to the course syllabus and can be used to develop a product (body of knowledge).

3) Computer-Supported Collaborative Tools (CSCT) are learning support tools used in knowledge sharing. There are two types of CSCT, synchronous and asynchronous, used to support different activities and peer interaction, facilitate sharing and distributing of knowledge, storage and delivery of content to those who need it and help members in an on-line learning community deal with problems more effectively. Examples of CSCT are: weblogs--for sharing texts, pictures and diagrams; Wikipedia--for editing projects and sharing ideas in group's work; web boards--for posting news, information or issues; chat/ MSN–for discussions with increased level of interactivity in on-line communication; and e-mail.

4) Transition and behavior management involves preparation and behavior adaptation for people joining the knowledge-sharing process in order to motivate target behavior and to adopt a willingness to achieve success in activities. In addition, transition and behavior management is used for solving problems and obstacles related to knowledge sharing. Support and a good learning environment are required to enable interaction which will lead to knowledge sharing. The following related factors have to be borne in mind: motivation, trust, and enabling learning environment.

5) Evaluation is the assessment of the products developed by the peer-assisted group learners. Next, the course manager and the peer-assisted group expert jointly evaluate the product, by discussing pros and cons and giving suggestions or advice that help the Peer-Assisted Group Learners to correct the imperfections and improve the product. Generally,

the Peer-Assisted Group Learners will create the assessment form for their own product assessment.

Moreover, to study learners' behavior which shows transition from tacit knowledge and explicit knowledge according to the concept of the SECI Model (Nonaka and Takeuchi, 1995), the Peer-Assisted Group Learners conduct self assessment before and after joining the knowledge-sharing process. This is an important step to monitor effects and efficiency of the process, particularly and is useful for the course manager to manage or adjust processes to be more efficient.

2. The process of knowledge-sharing was defined by six steps and each step has specific activities as follows:

The process of knowledge-sharing was continuous, with the first three steps performed sequentially; Steps 4 and 5 can be performed in any order or even simultaneously before proceeding to the last step. Firstly, the process started with orientation and group socialization to introduce and explain the course syllabus, teaching management, media, learning assessment, schedule, and assigning group participation to enhance the knowledge-acquiring atmosphere. The second section focused on knowledge identification to reach goals in which the Peer-Assisted Group Learners elicited project topics or problems through shared knowledge derived from opinions, suggestions and guidelines. The peer-assisted group expert helped in this section. The third section was a kind of forward-backward section, consisting of knowledge acquisition to develop products, knowledge sharing and peer meetings, and knowledge creation and revision. For knowledge acquisition to develop products, the Peer-Assisted Group Learners elicited and saved knowledge content for developing product outcomes.

Then, the group progressed to the section on knowledge creation and revision. While developing their product outcomes, they were able to move back to the section on knowledge acquisition to develop products to seek more knowledge content, or move forward to the fourth section on knowledge sharing and peer meetings at that time. Thus, they could convert knowledge, consult, ask for suggestions or help on any shared and issued topic, and apply this to their product outcome development. The sample group must repeat these three sections until they finish their product outcome development.

Next, the peer-assisted group learners who had finished their product outcome development proceeded to the next section (product evaluation and idea integration), which is the last step in the process. The peer-assisted group learners considered various data, recommendations and opinions in order to provide guidelines for product outcomes quality improvement. However, the whole process does not necessarily stop at the last step, where learners summarized the comments, suggestions or advice

Table 1 Means, standard deviations and t-test results of the difference between the pre-test and post-test knowledge-creation behaviors scores

Knowledge Creation Behaviors	$\bar{X}$	S.D.	t-test
Pre-test	2.11	0.59	13.93*
Pos-ttest	2.39	0.54	

* Significant at the .05 level

Table 2 Means and standard deviations of the product evaluation scores

Product Criterion	$\bar{X}$	S.D.	Level
Product development process	2.48	0.51	Good
Quality and possibility of implementation	2.43	0.50	Good
Innovation	1.88	0.49	Moderate
Total	2.39	0.51	Good

from the course manager and peer-assisted group expert to improve the product. Instead, learners could bring those issues back to Step 2 to define a new knowledge objective and start a new cycle of product creation as the continuing cycle of knowledge creation is crucial for ongoing growth of a knowledge-based society.

3. After using this process, knowledge-creation behaviors were analyzed by using a dependent t-test. Knowledge creation behavior scores of the post-test ($\bar{X}$ = 2.39) were significantly higher than those of the pre-test ($\bar{X}$ = 2.11) at the .05 level of significance. There were 26 behaviors (from a total of 40 behaviors) with knowledge-creation behavior mean scores that showed a significant pre-post difference ($P<0.05$) when examined by item. The knowledge-creation behavior mean scores of all four parts also showed significant pre-post differences ($P<0.05$) (see Table 1). The researchers concluded that these differences were due to the knowledge-sharing process which facilitated exchange of experience, knowledge and thoughts between participants. Peer assistance and support done through the CSCT allowed the graduate students to create effective products.

4. The Product Outcomes which were developed by the learners were assessed by three experts in the field of educational technology. The overall product outcomes were at good levels ($\bar{X}$ = 2.39 from a possible total score = 3, S.D.= 0.51) When assessed by each criterion, the product development process part ($\bar{X}$ = 2.48, S.D.= 0.51) and the quality and possibility of implementation part ($\bar{X}$ = 2.43, S.D.= 0.50) had scores at good levels. By contrast, the innovation part ($\bar{X}$ = 1.88, S.D.= 0.49) had scores at moderate levels (see Table 2).

Conclusions and Recommendations

In conclusion, the success of knowledge-sharing model depends on five components (people, content, computer-supported collaborative tools, transition and behavior management and evaluation) and the six-step processes (orientation and group socialization, knowledge identification to reach goal, knowledge acquisition to develop product, knowledge sharing and peer meetings, knowledge creation and revision and product evaluation and idea integration). The KM steps and processes identified in this research have helped graduate students to create products effectively and systematically.

Recommendations on the method for applying a knowledge-sharing model using CSCL based on a PAL approach to enhance knowledge-creation behaviors of graduate students include the following:

1) To use the model of knowledge-sharing efficiently, there must be readiness for the five elements (people, content, CSCT, transition and behavior management, and evaluation) which are relevant and affect the knowledge-creation behaviors of graduate students.

2) People who are relevant to the process must understand and participate well in all KM sections. They must have good attitudes, appreciation of the process and realize of its value and advantages in order to gain cooperation from participation to achieve the most efficient outcomes.

3) Educators should integrate the process with the course which promotes the knowledge-sharing practice and adjust activity times to suit with nature of each course.

4) There must be skills-building in knowledge-extraction, as most kinds of activities in this process are knowledge-seeking by relying on information sharing, conversion, exchange or transfer of information from data sources. Thus, the Peer-Assisted Group Learners should be trained in skills for listening, speaking, recording, extraction and thought reflection to apply knowledge content correctly and most profitably.

5) The model described above should be applied to courses providing peer-assisted group learners who share and link knowledge content, or experience to promote practices, or new knowledge outcomes, and integration with other courses. Knowledge-creation behavior needs time to achieve the target behaviors and requires reinforcement.

Application conditions concerning a knowledge-sharing model using CSCL based on a PAL approach to enhance knowledge-creation behaviors of graduate students include the following:

1) A knowledge-sharing model using CSCL based on a PAL approach to enhance knowledge-creation behaviors of graduate students were applied in order to develop self-knowledge outcomes. Future research should study different behaviors and contexts such as: knowledge searching ability and skill support, creative thinking support or visual practicing community.

2) Behavioral adjustment and management is an important factor in the knowledge-sharing model using CSCL based on a PAL approach. Future research should focus on specific points such as: motivation and trust in the activity, and relevant factors or environment and atmosphere management supportive of good learning.

3) In the development of the knowledge-sharing model using CSCL based on a PAL approach to enhance knowledge-creation behaviors of graduate students, the researchers have found that knowledge recording is an important behavior leading to new knowledge creation. Future research should be concerned with data-content saving and searching in knowledge acquisition and conversion.

4) From the results, peer-assisted group learners have the lowest evaluation scores for comparative thinking. Accordingly, there must be a process for skills development which focuses on skills in critical thinking, analysis, and comparison of knowledge content, experiences and thoughts, and also on skills of integrating prior knowledge with new knowledge.

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