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From knowledge sharing to knowledge creation: A blended knowledge-management model for improving university students' creativity

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ABSTRACT

Creativity and knowledge management are both important competences that university students need to strive to develop. This study therefore developed and evaluated an instructional program for improving university students' creativity based on a blended knowledge-management (KM) model that integrates e-learning and three core processes of KM: knowledge sharing, knowledge internalization, and knowledge creation. Moreover, this study investigated the underlying mechanisms that achieve the effectiveness of this model. A 17-week instructional program was conducted. The findings from both quantitative and qualitative analyses suggest the following. The blended KM model is effective in improving knowledge, dispositions, and abilities of creativity. The online sharing and evaluation of creative products, learning communities and discussions, and the practice of creativity strategies have substantial effects on all three aspects of creativity. The observation and peer evaluation of group assignments and creativity-related feedback enhance the learning of knowledge and dispositions. Finally, the creation of products and scaffolding of a teacher are critical to skill improvement.

1. Introduction

Recently, the cultivation of university students' creativity has been greatly emphasized. It has been suggested that creativity requires not only the application and sharing of knowledge but also the creation of knowledge (Gurteen, 1998). Knowledge management (KM), which is mainly characterized by knowledge sharing and knowledge creation (Alavi & Leidner, 2001; Ungaretti & Tillberg-Webb, 2011), has therefore become an important strategy for enhancing personal creativity. Methods for improving university students' creativity via a KM-based training, however, have scarcely been studied.

KM depends on several core competencies, including the acquisition of knowledge and storage, knowledge application, knowledge sharing, and knowledge creation (Alavi & Leidner, 2001). KM also emphasizes the integration of technologies (Gurteen, 1998; Schmidt, 2005). Recently, many information technology industries and educational institutions have attempted to integrate a blended knowledge management (KM) model into their human-resource training program and curriculum (e.g., Alony, Whymark, & Jones, 2007; Choi & Lee, 2003; Ferguson, Mathur, & Shah, 2005). While some models emphasize knowledge sharing (e.g., Alavi & Leidner, 2001; Bartol & Abhishek, 2002; Earl, 2001; Gagné, 2009), others value knowledge creation (e.g., Imani, 2007). However, only a few models emphasize the importance of internalization (e.g.,

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Nonaka & Kenney, 1991; Nonaka & Takeuchi, 1995). Internalization is a key process of cognitive learning (Vygotsky, 1986); it refers to the process of transforming explicit knowledge into tacit knowledge (Nonaka & Takeuchi, 1995). Moreover, it has been found that a blended learning approach that combines classroom instruction and e-learning is more effective than a pure e-learning approach (Osguthorpe & Graham, 2003). Accordingly, this study aimed to develop as well as to evaluate a blended KM-based training program for improving university students' creativity. In this model, knowledge sharing, internalization, and creation were emphasized and e-learning was integrated into classroom teaching. Moreover, this study aimed to investigate the underlying mechanisms that might achieve the effectiveness of the proposed blended KM model.

1.1. The definitions and elements of creativity

Creativity and innovation are sometimes regarded as the same concept. However, many researchers have suggested that they are two disciplined areas (e.g., Amabile, 1996; Baron & Tang, 2011; Hopkins, 2010; McLean, 2005). For example, Amabile (1996) claimed that creativity is the production of novel and useful ideas in any domain, whereas innovation is the successful implementation of creative ideas within an organization; all innovation begins with creative ideas. Baron and Tang (2011) concluded that creativity is often a necessary condition for subsequent innovations. In the same vein, McLean (2005) suggested that while the focus of creativity is primarily on the individual levels, innovation operates much more at the group and organizational levels; the focus of innovation is more on interrelationships and dynamics among actors and components of the organization and its environment. Since this study is focused in the individual level in educational settings, I used creativity, rather than innovation, in this study.

Since the advocate of creativity research by Guilford in 1950, proposed definitions of 'creativity' have changed from the unidimensional to the multidimensional plane; from factors related to personal characteristics to those concerning the social milieu; and from the cognitive to the affective domain (Yeh, 2011). What more recent works on creativity have emphasized, however, is that multiple components must converge in order for creativity to take place.

In her *Componential Model of Creativity*, Amabile (1996) defined creativity as the production of responses or works that are reliably assessed by appropriate judges as being original. Accordingly, she reported that three components are essential for the production of such responses and works: domain-relevant skills, creativity-relevant procedures and task motivation. In the *Evolving System Model of Creativity*, Gruber and Davis (1988) used the case study method to investigate the processes of highly creative individuals and proposed an evolving system model of creativity. They concluded that the creative person is unique, developmental change is multidimensional, and the creative person is an evolving system. They also reported that the evolution of creative ideas is influenced by an individual's expertise, motivation, emotions and environment. In the *Systems Model of Creativity*, Csikszentmihalyi (1990) proposed that three systems highlight creativity as the interactions of the field, the domain and the person. This model emphasizes that individuals create within a particular domain and that, therefore, domain knowledge is required. Similarly, in the *Interactive Perspective of Creativity*, Gardner (1993) underscored the interaction of three core elements: the individual, other persons and the work. Moreover, in the *Investment Theory of Creativity*, Sternberg and Lubart (1996) claimed that creative people are willing and able to "buy low and sell high" in the realm of ideas. They also suggested that a confluence of six distinct but interrelated resources is required for creativity. These are intellectual ability, knowledge, particular style of thinking, personality, motivation and the environment. More recently, Yeh (2004) proposed the *Ecological Systems Model of Creativity* based on a thorough review of these well-known confluence models of creativity. This model emphasized that creativity is a process in which an individual generates a culturally and contextually original and valuable product in a specific domain, which derives from the interaction of four systems. The microsystem specifies personal characteristics; mainly knowledge, dispositions, and skills and strategies; the mesosystem consists of family and school experiences; the exosystem comprises organizational factors that relate to an individual's work; and the macrosystem refers to a social milieu.

Although the aforementioned literature shows that creativity may be influenced by multiple systems, a consensus exists that among these influential factors, personal characteristics have the most direct and strongest effects on an individual's creative performance, and such characteristics can be divided into three categories: knowledge, disposition, and abilities (Yeh, 2006). Sweller (2009) declared that the first element of creativity is a comprehensive knowledge base. Baer (2008) concluded that creativity is best conceptualized as domain specific. Crawford and Brophy (2006) also argued that creativity requires a basic level of expertise and fluency within a specific knowledge domain along with deep knowledge of the subject. Apparently, knowledge is the most fundamental and critical element of creativity.

As for dispositions, the second element, their importance has been highly emphasized in famous creativity models (e.g., Amabile, 1996; Sternberg & Lubart, 1996). Tinerney and Farmer (2002) found that personal self-confidence or self-efficacy helps to foster creative behavior. Claxton, Edwards, and Constantinou (2006) have also illustrated that dispositions such as curiosity, resilience, experimentation, attentiveness, and thoughtfulness are important for the performance of creativity. Based on a thorough literature review and empirical findings, Yeh (2006) identified nine categories of personality traits pertaining to creativity: tryout, joy in work, adaptive cognition, multidimensional reasoning, independence, problem-solving, interaction and prudence, interest, and intuition and imagination; she found these personality traits were positively related to an individual's creativity. These nine categories of personalities were measured in this study.

As for abilities, the third element, Martins and Terblanche (2003) regarded creativity as a kind of capacity that integrates many new ideas for products, services, processes, and procedures. Pelled, Eisenhardt, and Xin (1999) declared that the range

of skills, knowledge, and perspectives positively impact an individual's creative performance. Cremin, Burnard, and Craft (2006) also argued that creativity involves using imagination and new thinking strategies. Along the same line, Crawford and Brophy (2006) argued that creativity requires the ability to understand relationships among facts and concepts, to recognize patterns of information, and to organize content into conceptual frameworks. In addition, Feldhusen (1995) pointed out that the process of creation requires abilities of planning and monitoring. Yeh (2004) found such problem-solving abilities as organizing and analyzing problems, planning and adjusting working progress, staying judgmental in solving problems, and being sensitive in observation were positively related to creative performance. Therefore, both cognitive and metacognitive abilities are essential for creative performance.

1.2. The definitions of KM and KM-based training models

Ungaretti and Tillberg-Webb (2011) claimed that KM involves the process of acquiring, capturing, sharing, using, and creating of knowledge. Along the same line, Alavi and Leidner (2001) argued that KM involves the following processes: acquisition of knowledge and storage, knowledge application, knowledge sharing, and knowledge creation. To date, most KM studies are undertaken in the context of industrial organizations, and most definitions of KM have therefore focused on organizational improvement. For example, Jennex (2005) claimed that with the purpose of improving organizational effectiveness, KM is the practice of selectively applying knowledge from previous experiences to current or future decision-making activities. In the same vein, Holsapple and Joshi (2004) declared that KM involves making deliberate efforts to expand, cultivate, and apply available knowledge in ways that add value to an organization.

Among the KM theories, the SECI model is well-known and derives from studies of knowledge creation in innovating organization (Gourlay, 2003; Nonaka & Kenney, 1991; Nonaka & Takeuchi, 1995). The SECI model includes four processes of knowledge transformation: socialization, externalization, combination, and internalization. Socialization focuses on tacit-to-tacit-knowledge linking; externalization focuses on the tacit-to-explicit-knowledge processes; combination focuses on explicit-to-explicit-knowledge sharing; and internalization focuses on explicit-to-tacit-knowledge transformation (Nonaka & Takeuchi, 1995). Having extended from the SECI model, many researchers have argued that knowledge sharing and knowledge creation are key components of a successful application of KM (e.g., Alavi & Leidner, 2001; Earl, 2001; Kinney, 1998; Swirski, Wood, & Solomonides, 2008).

As far as knowledge sharing is concerned, it involves the process of converting knowledge and creating new knowledge (Van den Hooff & De Ridder, 2004) as well as the process of sharing relevant information, ideas, suggestions, and expertise with others (Bartol & Abhishek, 2002). Accordingly, knowledge sharing has been considered as a key component of KM systems and the most important element of creative behaviors in any organizations (Alavi & Leidner, 2001). As for influential factors of knowledge sharing, Riege (2005) suggested that factors influencing knowledge sharing may include individual factors (e.g., trust, power, and leadership), organizational factors (e.g., social network, reward system, and sharing opportunities), and technological factors (e.g., information technology systems and member training). Along the same line, Park, Ribiere, and Schulte (2004) argued that organizational culture that encourages teamwork and autonomy improves knowledge sharing. Ipe (2003) also claimed that the nature of knowledge may influence the possibility of knowledge sharing and that the perceived value of knowledge influences people's motivation for sharing. In a SECI-based study, Yeh, Huang, and Yeh (2011) also found that building a learning community, engaging in observational learning, and participating in both class and online group discussions contributed to knowledge sharing.

As for knowledge creation, Kinney (1998) declared that KM is an organizational mechanism for enhancing knowledge creation and defined KM as "the process by which an organization creates, captures, acquires, and uses knowledge to support and improve the performance of the organization" (p. 2). Knowledge creation involves the analysis, application, and expansion of knowledge; it encourages individual learning and confidence, lifelong learning, and learning within communities (Swirski et al., 2008). As for factors that influence knowledge creation, Nonaka and his colleagues (Nonaka & Takeuchi, 1995; Nonaka & Toyama, 2003) proclaimed that knowledge creation starts with socialization, the process of converting new tacit knowledge through shared experiences in social interaction, and that tacit knowledge can be acquired through direct sharing of experiences, such as spending time together in the same environment. Leroy and Ramanantsoa (1997) also suggested that explicit knowledge can be easily transformed and acquired via practicing, reinforcement, imitation, and socialization.

While knowledge sharing and knowledge creation have been popularly emphasized in KM definitions and KM applications, knowledge internalization has been neglected. According to Vygotsky (1986), internalization is a key process of cognitive learning. Nonaka and Takeuchi (1995) also identified internalization as the key process of transforming explicit knowledge to tacit knowledge. Accordingly, an effective KM-based training should simultaneously take knowledge sharing, creation, and internalization into consideration. As for knowledge internalization, although tacit knowledge is difficult to concretize, it can be internalized through experiences of trial and error, hands-on curriculum, and observational learning (Leroy & Ramanantsoa, 1997; Lam, 2000). In an empirical study of teacher training based on the SECI model, Yeh et al. (2011) found that participation in both in-class and online discussions enhances self-reflection and provides abundant practice for the internalization of knowledge. In the same line, a few studies have found that enhancing self-awareness and mindfulness can facilitate reflective practices (e.g., Tillema, 2000; Yeh et al., 2011) and providing appropriate feedback can enhance self-awareness and mindful learning (Titone, Sherman, & Palmer, 1998). Accordingly, knowledge internalization can be effectively facilitated when teaching strategies are appropriately used.

1.3. KM and creativity

Based on theories of KM and e-learning, some researchers (e.g., Craft, 2005; Paavola, Lipponen, & Hakkarainen, 2004) have defined creativity as the process of knowledge building and learning via new technology or designed media. Du Plessis (2007) proposed that KM allows collaboration, knowledge sharing, continual learning, and improvement. Moreover, KM plays five major roles in creativity: (1) it enables the codification and sharing of tacit knowledge; (2) it makes explicit knowledge available for producing creative ideas; (3) it enables the transfer of tacit knowledge via collaborative processes; (4) it manages various activities in the KM process, such as creation, gathering, sharing, and implementation of knowledge; and (5) it conduces knowledge sharing and creation as well as collaboration through the creation of a culture. Gloet and Terziovski (2004) also found that KM is positively related to creative performance. Accordingly, the appropriate use of KM should enhance the learning of creativity.

As aforementioned, knowledge sharing, knowledge internalization, and knowledge sharing are three core processes of KM, and knowledge internalization can serve as the bridge between knowledge sharing and knowledge creation. Therefore, these three KM processes may interactively influence personal creativity if the instructional program is well designed.

2. Hypotheses of this study

The SECI model can be viewed as a comprehensive model of knowledge creation in the KM system, and internalization plays a key role in the process of knowledge creation. Gagné (2009) also suggested that people's attitudes toward sharing will be more positive when they internalize the value of sharing knowledge. Moreover, knowledge sharing and knowledge creation are commonly emphasized in recent KM models. This study therefore tried to integrate the three key processes of KM (knowledge sharing, knowledge internalization, and knowledge creation) into a blended training program to improve university students' creativity as well as to investigate its underlying mechanisms. Based on the aforementioned literature concerning influential factors of KM and the practical limitations in higher education, we proposed that a blended KM training program for improving university students' creativity could employ learning community and observational learning to facilitate knowledge sharing, enhance self-awareness and self-reflection as well as provide practices and interactions to facilitate knowledge internalization, and conduct group discussion and interaction as well produce creative products to facilitate knowledge creation.

Although developing a KM-based training program and evaluating its effectiveness on improving university students' creativity as well as exploring its underlying mechanisms were important goals of this study, only hypotheses focusing on testing creativity improvement were proposed in this study. In this study creativity includes three indicators: knowledge, dispositions, and abilities. Accordingly, the proposed hypotheses were: (1) blended KM-based instruction would improve university students' knowledge of creativity; (2) blended KM-based instruction would improve university students' dispositions of creativity; and (3) blended KM-based instruction would improve university students' creative abilities.

3. Method

3.1. Participants

The participants were 36 university students (19.4% of males and 80.6% of females) with a mean age of 21.03 ($SD = 4.14$). They were prepared to be secondary school teachers and were enrolled in the course of "Instruction of creativity".

3.2. Instruments

The instruments employed in this study were the NCCU e-learning platform (http://wm3.nccu.edu.tw/learn/index.php), the *Inventory of Knowledge in Creativity* (IKC), the *Inventory of Personal Factors in Technological Creativity Development* (IPF-TCD), the *New Creativity Test* (NCT), and a reflective questionnaire. The NCCU e-learning platform consisted of an Information Center, Assessment Center, Communication Center, Personal Area, and Public Zone.

Both the IKC and the IPC were designed on a 6-point Likert scale with response options ranging from "totally disagree" to "totally agree." The IKC, adapted from the *Inventory of Professional Knowledge in Creativity Instruction* (Yeh et al., 2011), comprised one indicator (5 items). The total variance explained was 74.28%, and the Cronbach's α coefficient was 0.93. The test items measured whether the participants understood (1) the definition of creativity, (2) the prerequisites of creativity, (3) influential factors of creativity, (4) personalities of creativity, and (5) abilities of creativity. In addition, each of the IKC items requested that participants describe their knowledge related to the item to check their knowledge in creativity. This written portion was scored on a 100-point scale. For example, the test item called "I can clearly define creativity" was accompanied by a request to define creativity.

The IPF-TCD was used to measure the participants' dispositions of creativity. Composed of 41 items, the IPF-TCD included nine indicators: tryout, joy in work, adaptive cognition, multiple-perspective reasoning, independence, problem-solving, interaction and prudence, interest, and intuition and imagination. The Cronbach's α coefficients were 0.64–0.89 for the nine indicators and 0.95 for all items (Yeh, 2004).

The NCT included a verbal test and a figural test (Wu, 1998). Both tests were employed in this study to measure participants' abilities of verbal and figural creativity. Similar to the *Torrance Tests of Creative Thinking* (TTCT) (Torrance, 1966), the verbal test required the participants to list alternative uses of chopsticks, and the figural test required the participants to draw pictures based on the Chinese character "人" (people). In this study, the scoring indices of both tests included fluency, flexibility, and originality. Each of the tests had a 10-min limit. The inter-rater reliability coefficients for the three indices in both tests ranged from 0.93 to 0.98. As for criterion-related validity, the verbal test had significant correlations with Torrance's "Can" task, $rs = 0.70$, 0.62 ($ps < 0.001$), and 0.08 ($p < 0.05$). The figural test had significant correlations with Torrance's "parallel lines" task, $rs = 0.75$, 0.63, and 0.57 ($ps < 0.001$) for the three indices, respectively.

Finally, owing to the difficulty of getting a control group with a pure e-learning approach and based on the advantages of content analysis, we designed a reflection questionnaire consisting of six open-ended questions based on the instructional design of this study to confirm the effectiveness of the instructional design employed in this study as well as to investigate the underlying mechanisms that achieve the success of such a design. The questions and their summarized responses are shown in Section 4. Content analysis focuses on data representations of texts, images, interpretations, and expressions acted on for their meanings. Moreover, content analysis helps understand what is mediated between people-textual matters, information, and technology-supported social interactions. Content analysis is therefore powerful and unobtrusive (Krippendorff, 2004); it provides in-depth information for achieving our goals in this study.

3.3. Experimental design and procedures

This study used a before-and-after design. A 17-week experimental instruction program, which integrates the theories of KM and blended learning, was employed and administered by the first researcher. While the pretests were administered in the first week, the posttests were given in the 17th week. The pretests included the IKC, the IPF-TCD, and the NCT, whereas the posttests also included the reflection questionnaire. In the second week, the participants were divided into eight self-determinate groups and were requested to complete a cooperation contract which stated their learning goals and resolutions for conflicts among group members. In the following week, they were requested to complete a series of group assignments to develop learning communities. The goal of this experimental instruction was to enhance the participants' creativity (including knowledge, dispositions, and abilities) via knowledge sharing, knowledge internalization, and knowledge creation. To enhance knowledge sharing, learning community and observational learning were encouraged. To facilitate knowledge internalization, self-awareness and self-reflection were enhanced, and abundant practices and interactions were provided. Finally, to achieve knowledge creation, group discussion and interaction were facilitated, and designs of creative products were requested. In all stages, corresponding lectures were given to achieve the instructional goals. More details of in-class and online activities are shown in Fig. 1.

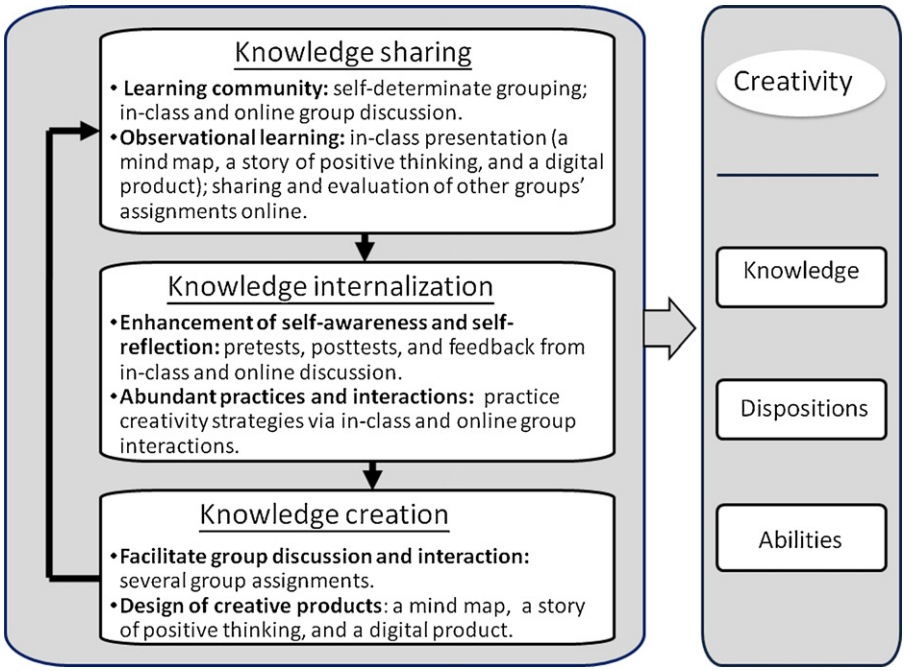

Fig. 1. Instructional design.

Past study findings have suggested that a blended learning approach that combines in-class learning and e-learning is more effective than a pure e-learning approach (Osguthorpe & Graham, 2003) and students are not satisfying with the pure online discussion approach (LaPointe & Reisetter, 2008). Moreover, while online discussion allows learners to go beyond the space and time constraints and provides support for community building (Gao, 2011), the face-to-face discussion is more prompt in responses, easier to reach consensuses, and more multidirectional in interaction (Wang & Woo, 2007). Accordingly, in-class learning and e-learning (or online learning) are complimentary and both types of learning were interactively employed in this study. Specifically, blended learning was emphasized in this study and several topic discussions were assigned and scored based on discussion frequencies to facilitate online interactions as well as to solve the problem of insufficiency of discussion time. The topic discussions focused on personal and group assignments. The personal assignments included the sharing of creative products and personal digitalized creative products, while the group assignments included mind maps and stories of positive thinking. Moreover, all assignments that represented knowledge creation were achieved via the scaffolding of going through the processes of knowledge sharing, knowledge internalization, and knowledge creation.

3.4. Data analysis

Repeated Measure Analysis of Variance (Repeated Measure ANOVA) was used to evaluate the effectiveness of the designed program. Moreover, content analysis of the reflection questionnaire was used to validate the instructional effectiveness of the designed program and to determine the underlying mechanisms of instructional effectiveness. In this study, content analysis was conducted by two trained doctoral students. The researchers first independently reviewed each item of the reflection questionnaire and generated initial checklists of categories and concepts for each item. Next, they compared the categories and concepts and revised the initial checklists as necessary. They then created a consolidated checklist. Finally, the consolidated checklist was reviewed and revised by the first researcher. After the checklist was completed, it was used independently to apply coding by the two trained doctoral students. Discussions were conducted to reach a consensus when inconsistencies of coding occurred.

4. Results

4.1. Improvements in knowledge of creativity

Table 1 and Fig. 2 depict the participants' mean scores in the IKC. For the Likert-type scale, the results of Repeated Measure ANOVA yielded a significant test (pretest vs. posttest) effect on the overall score of the IKC (Wilks' $\Lambda = 0.625$, $p = 0.000$, $\eta_p^2 = 0.375$). For the written portion, a significant test (pretest vs. posttest) effect was also found (Wilks' $\Lambda = 0.253$, $p = 0.000$, $\eta_p^2 = 0.747$). Comparisons of means in both the Likert-type scale and the writing test revealed that the participants had more abundant knowledge of creativity in the posttest than in the pretest.

4.2. Improvements in dispositions of creativity

Table 2 and Fig. 3 depict the participants' mean scores in the IPF-TCD. Again, the results of a Repeated Measure ANOVA yielded a significant test (pretest vs. posttest) effect on the overall score of the IPF-TCD (Wilks' $\Lambda = 0.771$, $p = 0.007$, $\eta_p^2 = 0.229$) (See Table 2). A comparison of means revealed that the participants had a higher degree of creativity dispositions in the posttest than in the pretest.

Table 1
Participants' mean scores and standard deviations in the IKC ($N = 31$).

Indicator	Pretest		Posttest	
	M	*SD*	*M*	*SD*
Likert-type scale				
Definition	3.323	1.013	4.226	0.717
Prerequisite	3.258	0.930	4.258	0.729
Factors	3.581	1.148	4.194	0.792
Personalities	3.742	0.965	4.419	0.564
Abilities	3.032	1.048	4.032	0.912
Total	3.387	0.813	4.226	0.628
Writing				
Definition	4.829	2.640	8.600	3.323
Prerequisite	3.857	2.840	8.928	2.908
Factors	3.914	2.639	8.786	2.878
Personalities	5.286	2.270	9.114	3.596
Abilities	2.371	2.340	8.271	4.175
Total	4.051	1.572	8.740	2.871

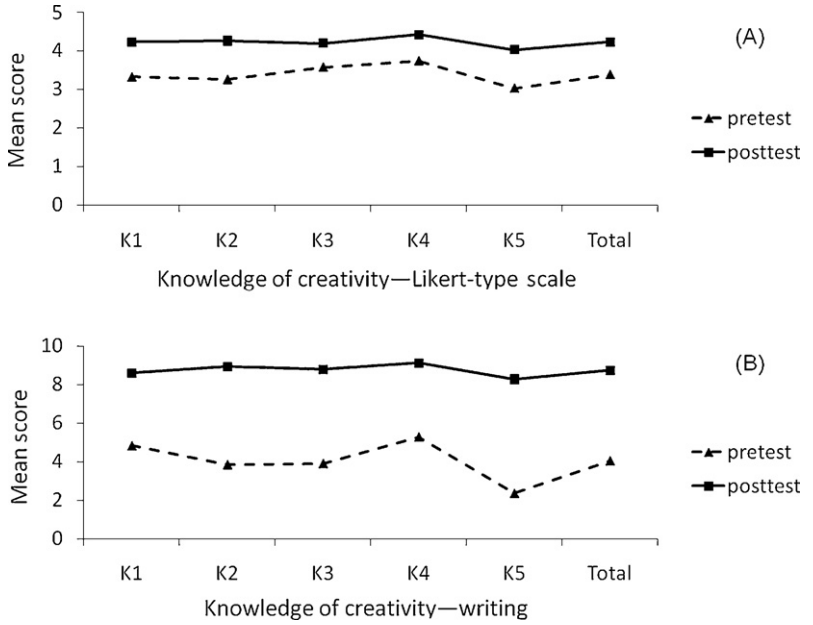

Fig. 2. Mean scores of the IKC in the pretest and the posttest. *Note*. K1, definition of creativity; K2, prerequisites of creativity; K3, influential factors of creativity; K4, personalities of creativity; K5, abilities of creativity.

Table 2
Participants' mean scores and standard deviations in the IPF-TCD ($N = 29$).

Indicator	Pretest		Posttest	
	M	*SD*	*M*	*SD*
Tryout	4.148	0.7487	4.414	0.736
Joy in work	4.821	0.4938	4.917	0.465
Adaptive cognition	4.359	0.6378	4.490	0.638
Multiple-perspective reasoning	4.195	0.6010	4.437	0.777
Independence	3.883	0.7865	4.069	0.923
Problem-solving	4.115	0.7442	4.305	0.728
Interaction and prudence	4.681	0.6440	4.862	0.589
Broad Interest	4.632	0.7885	4.828	0.727
Intuition and imagination	4.379	0.6219	4.575	0.666
Total	4.326	0.5316	4.514	0.550

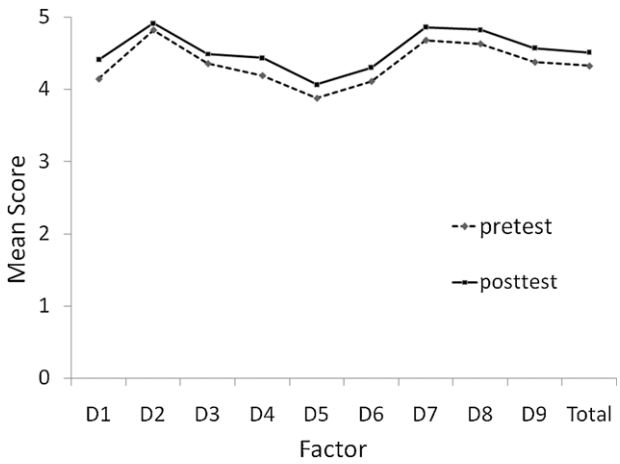

Fig. 3. Mean scores of the IPF-TCD in the pretest and the posttest. *Note*. D1, tryout; D2, joy in work; D3, adaptive cognition; D4, multiple-perspective reasoning; D5, independence; D6, problem-solving; D7, interaction and prudence; D8, broad interest; D9, intuition and imagination.

Table 3
Participants' mean scores and standard deviations in NCT ($N = 36$).

Indicator	Pretest		Posttest	
	M	*SD*	*M*	*SD*
Verbal creativity				
Fluency	15.222	8.054	23.556	9.479
Flexibility	9.639	4.350	11.694	3.206
Originality	13.028	9.999	23.083	12.394
Figural creativity				
Fluency	13.361	5.383	24.500	8.272
Flexibility	9.333	2.888	13.889	4.301
Originality	12.722	7.118	24.111	11.257

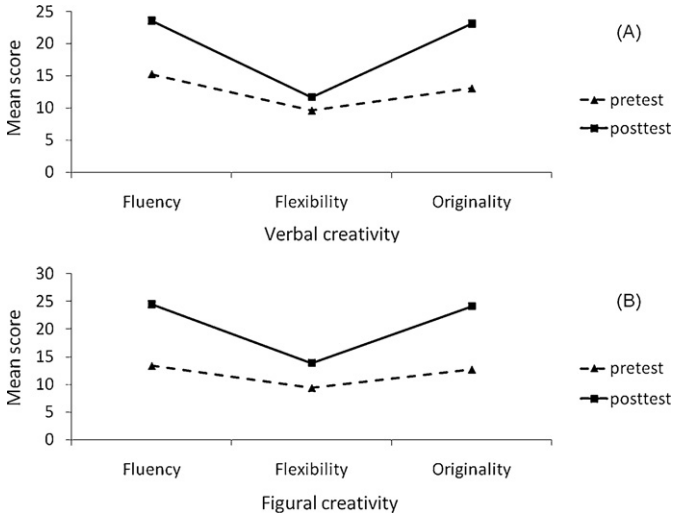

Fig. 4. Mean scores of creativity abilities in both the pretest and the posttest.

4.3. Improvements in abilities of creativity

In this study, both verbal and figural creativity were measured by three indices: fluency, flexibility, and originality. Table 3 and Fig. 4 depict the participants' mean scores on these indices. For verbal creativity, the results of Repeated Measure ANOVA yielded significant test (pretest vs. posttest) effects on fluency (Wilks' $\Lambda = 0.543$, $p = 0.000$, $\eta_p^2 = 0.457$), flexibility (Wilks' $\Lambda = 0.771$, $p = 0.003$, $\eta^2 = 0.229$), and originality (Wilks' $\Lambda = 0.586$, $p = 0.000$, $\eta_p^2 = 0.414$) (Table 4). Comparisons of means revealed that the participants showed better verbal creativity on the posttest than on the pretest in all three aspects.

For the figural creativity, the results of Repeated Measure ANOVA also yielded significant test (pretest vs. posttest) effects on fluency (Wilks' $\Lambda = 0.227$, $p = 0.000$, $\eta_p^2 = 0.773$), flexibility (Wilks' $\Lambda = 0.430$, $p = 0.000$, $\eta_p^2 = 0.570$), and originality (Wilks' $\Lambda = 0.352$, $p = 0.000$, $\eta_p^2 = 0.648$) (Table 4). Comparisons of means revealed that the participants had better figural creativity on the posttest than on the pretest in all the three aspects.

Table 4
Multivariate tests of improvements in verbal and figural creativity.

Source	Wilks' Λ	*F*	Hypothesis *df*	Error *df*	Sig.	η^2
Verbal creativity						
Fluency	0.543	29.481	1	35	0.000	0.457
Flexibility	0.771	10.400	1	35	0.003	0.229
Originality	0.586	24.768	1	35	0.000	0.414
Figural creativity						
Fluency	0.227	119.311	1	35	0.000	0.773
Flexibility	0.430	46.455	1	35	0.000	0.570
Originality	0.352	64.379	1	35	0.000	0.648

4.4. Mechanisms for improvements in creativity

To further understand the effectiveness of the employed experimental instruction, six open-ended questions were included in this study. Content analysis was used to analyze the participants' responses in these questions. The results of these analyses are presented in Tables 5–10.

Q1: This class employed blended learning (an integration of e-learning and classroom instruction). Did such a design enhance knowledge sharing and creation? How?

Most participants (91.7%) responded that the blended learning design enhanced their knowledge sharing and creation. Knowledge creation primarily came from online discussions (13.9%), whereas knowledge sharing was mainly derived from the sharing and evaluation of group assignments (77.8%). Although 8.3% of the participants disagreed that this instructional design was effective, only 2.8% of the participants preferred the pure classroom instruction.

Q2: Did the assignments of sharing and commenting on creative products online contribute to your understanding and appreciation of creative ideas or creativity? How?

All participants responded positively to this question. The most important reason that involved knowledge improvement (66.7%) was that it helped participants begin to think about and understand what creative ideas are (27.8%). Other responses cited disposition improvement (22.2%) in that it aided participants in becoming sensitive to creative ideas in daily life (19.4%), and others cited ability improvement for stimulating thoughts of producing a creative product (11.1%). The mechanisms of such improvement mostly involved the online sharing, searching, and commenting on creative products.

Q3: What were the major learning benefits in reading peer assignments on the e-learning platform?

The participants' responses revealed that such an activity contributed to their knowledge improvement (95.7%) and disposition improvement (4.3%). The main reasons for knowledge improvement involved learning how to stimulate personal creativity (45.7%) and understanding others' creative ideas (30.4%). The reasons for disposition improvement involved facilitating reflection on personal creativity (4.3%).

Q4: How do you feel about the discussions and feedback of online topic discussions?

A significant majority (97%) responded positively and suggested that the topic discussions contributed to their improvements in knowledge (38.8%), dispositions (20.9%), and abilities (37.3%) pertaining to creativity. Among the reasons, peer evaluation played a key role in knowledge improvement (26.9%); peer evaluation, observational learning, and stories of positive thinking contributed to disposition improvement; and observational learning, stories of positive thinking, and mind maps contributed to ability improvement. The two negative responses (3.0%) involved complaints concerning the difficulty of opening discussion files and the excessive amount of discussion content to read.

Q5: Did the blended learning design contribute to your improvements of creativity? How?

Most participants (75%) agreed that the blended learning employed in this study improved their creativity. The e-learning platform (39.6%) provided opportunities for performing, sharing, observational learning, and online discussion of creativity, while the classroom instruction (49.1%) provided theories and materials of creativity, opportunities for practicing creative strategies, cooperation, and discussion. For those who responded negatively (25%), their main complaint was that e-learning did not directly improve creativity (7.6%).

Q6: Did the blended learning design help you reflect on your abilities and dispositions of creativity?

A significant majority of the participants (91.7%) responded positively to this question. The evaluation and sharing of assignments from the e-learning platform (50.0%) as well as feedback and evaluation, illustrations and practices of creative strategies, and classroom discussions from class instruction (41.7%) all contributed to the participants' self-reflection on abilities and dispositions of creativity. The 8.3% who responded negatively cited a lack of habits in self-reflection and too little improvement as their main complaints (8.3%).

5. Discussion

In this study, we proposed that KM includes three processes—knowledge sharing, knowledge internalization, and knowledge creation, and that integrating these processes of KM with blended learning would improve university students' creativity. A blended KM model based on these assumptions was therefore constructed. To validate this model, a 17-week instructional program was conducted, and three hypotheses regarding the instructional effects on knowledge, dispositions, and abilities of creativity were examined. All proposed hypotheses were supported by the significant effects yielded from Repeated Measure ANOVA and positive responses in the reflection questionnaire. Specifically, the results of Repeated Measure ANOVA show that after receiving the instructional program, the participants significantly improved their knowledge (in the questionnaire portion, $\eta_p^2 = 0.375$; in the writing portion, $\eta_p^2 = 0.747$), dispositions ($\eta_p^2 = 0.229$), and abilities of creativity (the η_p^2s of the verbal fluency, flexibility, and originality were 0.457, 0.229, and 0.414; the η_p^2s of the figural fluency, flexibility, and originality were 0.773, 0.570, and 0.648, respectively). Comparatively, the instructional effects on knowledge and abilities (especially figural abilities) seem to be more significant than those on dispositions. These findings suggest that the blended KM model is valid and that the instructional program is effective in improving university students' key elements of creativity. Moreover, the improvement of dispositions may be more difficult than that of knowledge and abilities.

In this study, knowledge sharing was facilitated via community-building and observational learning. Learning communities are a collaborative means of achieving "shared creation" and "shared understanding," in which interactions are

encouraged to support individual and collective learning (Ludwig-Hardman & Woolley, 2000). In this study, the building of community was encouraged via self-determinate grouping and group discussions, which further influenced knowledge sharing and therefore improved the participants' creativity. These findings are in line with the findings that learning community is critical to knowledge sharing (Yeh et al., 2011) and knowledge sharing plays a key role in the learning of creativity (Du Plessis, 2007). On the other hand, this study found that observational learning was achieved via in-class presentation, online sharing, and peer evaluation. To facilitate knowledge internalization, self-awareness and self-reflection were enhanced by giving out test results and feedback on in-class and online discussions. Abundant practice in employing creativity strategies and in-class and online interactions were also provided. Finally, to achieve knowledge creation, group discussions and interactions along with designs of a series of creative products were requested. KM involves the interaction and transformation between explicit knowledge and implicit knowledge. Through these in-class and online learning activities, the participants were able to integrate explicit and implicit knowledge into their knowledge systems, thereby increasing their creativity. Such findings support the propositions that explicit knowledge is acquired through practice, reinforcement, imitation, and socialization (Leroy & Ramanantsoa, 1997) and that tacit knowledge can be internalized through immersion (Baumard, 1999), experience and trial-and-error (Leroy & Ramanantsoa, 1997), learning-by-doing (Lam, 2000), observation, imitation, and practice (Nonaka, 1991b). Moreover, this study emphasized the practice of collaborative learning and social interaction via an abundance of group assignments and discussions. The effectiveness of such a design lines up with the claim that students' collective efforts contribute to making ideas visible (Scardamalia & Bereiter, 2006) and that creating an optimal learning environment by focusing on social interaction not only facilitates meaningful learning but also develops students' creativity (McWilliam & Dawson, 2007).

To validate the effectiveness and the underlying mechanisms of the designed model, a reflection questionnaire was employed at the end of the experimental instruction. The analytical results indicated that most participants had positive responses toward the instructional design and that the blended KM design facilitated their knowledge sharing, creation (question 1), and internalization (question 6). Moreover, the assumed mechanisms that facilitate knowledge sharing, internalization, and creation were validated by the participants' responses. For example, the participants responded that online sharing and evaluation of group assignments facilitated their knowledge sharing (question 1), that online discussions contributed to their knowledge creation (question 1), and that the feedback of evaluation, discussions, and practices of creative strategies enhanced their self-reflection (question 6). In addition, the participants' responses suggest that online learning and in-class learning play complementary roles in learning creativity. For example, the participants responded that the e-learning platform contributed to their knowledge sharing, knowledge creation, observational learning, and online discussion, while classroom instruction helped them to build a knowledge base, learn basic skills, and conduct in-depth discussion (question 5). Accordingly, both e-learning and in-class learning contribute to improvements in knowledge, dispositions, and skills of creativity in different ways.

To further understand the underlying mechanisms of the designed model in this study, we tried to integrate the participants' responses in the reflective questionnaire and to depict the relationships among important concepts in Fig. 5. Specifically, online sharing and the evaluation of creative products, discussions, and the practice of creativity strategies have great effects on the three aspects of creativity. Observation and peer evaluations of group assignments influence the learning

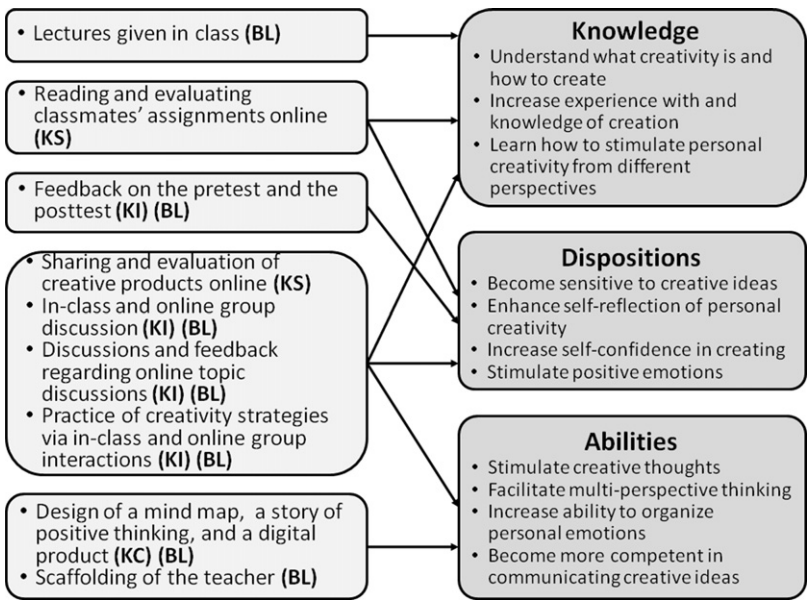

Fig. 5. Relationships among teaching strategies and improvements of creativity based on the six open questions *Note.* BL, blended learning; KS, knowledge sharing; KI, knowledge internalization; KC, knowledge creation.

of knowledge and dispositions. Feedback on creativity-related evaluation contributes to the enhancement of dispositions, and the creation of products and scaffolding are critical to the improvement of skills. These results also indicate that while blended learning, knowledge sharing, and knowledge creation all tribute to the improvements of creativity as expected, knowledge internalization seems to play a key role in such improvements.

According to Nonaka and Takeuchi (1995), knowledge sharing is essential for converting common ideas and concepts into innovative products. Similarly, Martins and Terblanche (2003) stated that creativity and innovation result from shared visions and missions. On the other hand, Martensson (2000) argued that a successful model for implementing KM strategies into creation must include creativity. Similarly, Kao (1997) claimed that a good strategy for KM is not enough and that connecting KM strategies to creativity would lead to a more competitive organization. Gurteen (1998) also claimed that KM is an emerging set of principles that help knowledge workers develop their creativity. Du Plessis (2007) declared that KM plays a key role in creativity. The findings of this study support these arguments and confirm the close relationship between KM and creativity. Moreover, the results in this study support the finding that integrating technology into KM practices can facilitate knowledge sharing, creation, and meaningful learning (Cartelli, 2007; Yeh et al., 2011).

This study emphasized the building of community and autonomy, the positive effects of which support the claim that these mechanisms are important to knowledge sharing (Park et al., 2004; Riege, 2005). This study also integrated the elements of practices, in-class and online discussions, and feedback to facilitate knowledge creation, the positive effects of which support the ideas that practices, social interactions, and reinforcement are critical to knowledge creation (Leroy & Ramanantsoa, 1997; Yeh et al., 2011). Finally, the findings in this study confirm that abundant practices, enhancement of self-reflection, and knowledge sharing contribute to knowledge internalization (Leroy & Ramanantsoa, 1997).

6. Conclusions

Creativity and knowledge management are both regarded as key components for success in this epoch. In educational settings, KM studies that focus on improving creativity are still developing. Past KM studies, especially those that involve training, seldom emphasize the importance of knowledge internalization. This study therefore developed a blended KM instructional model that integrates e-learning with knowledge sharing, internalization, and creation to improve university students' creativity. The positive effects obtained from both the qualitative and quantitative data not only support the effectiveness of this model but also help clarify the underlying mechanisms of such success. In addition, this study is unique in that it seeks to improve creativity from its three key elements (knowledge, dispositions, and skills) rather than focusing only on one aspect. The study's findings also suggest that these three key elements can be simultaneously enhanced to optimize the learning effect of creativity.

Due to the difficulty of getting a control group to finish all the pretests and posttests, this study employed a before-and-after design. To compensate for this disadvantage, both quantitative and qualitative methods were employed. The highly consistent results of these two approaches suggest that the findings in this study are reliable and valid. Future studies, however, may validate the findings of this study by adding a control group. Moreover, it has been suggested that creativity is crucial to knowledge sharing and creation. For example, Basadur and Gelade (2006) claimed that adaptability and flexibility are important for efficient knowledge sharing and creating. Adaptability refers to the seeking out of new problems, information, and technologies and using these resources to create new products. Flexibility, on the other hand, refers to changing risk events into opportunities via the achievement of goals in new ways. Sie, Bitter-Rijpkema, Sloep, and Retalis (2009) also argued that the system integrates creative techniques and pedagogical strategies into KM that are the most effective types for knowledge sharing. This study examines how KM influences creativity. Further studies may conversely investigate how creativity influences KM.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.tsc.2012.05.004.

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