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Knowledge management in blended learning: Effects on professional development in creativity instruction

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ABSTRACT

The purposes of this study were (1) to develop a teacher training program that integrates knowledge management (KM) and blended learning and examine its effects on pre-service teachers' professional development in creativity instruction; and (2) to explore the mechanisms underlying the success of such KM-based training. The employed KM model was the SECI, which consists of four modes of knowledge conversion: socialization, externalization, combination, and internalization. Forty-four pre-service teachers participated in this 17-week experimental instructional program. Repeated Measure Analysis of Variance and content analysis revealed that the training program designed in this study effectively improved pre-service teachers' professional knowledge and personal teaching efficacy in their teaching of creativity. Moreover, this study showed that blended learning, guided practice, observational learning, group discussion, peer evaluation, and feedback are important mechanisms underlying this success.

1. Introduction

Creativity, defined as the process in which an individual generates a contextually and culturally original and valuable product within a certain domain, plays a crucial role in today's society (Yeh, 2004). It is generally agreed that certain basic elements of creativity can be nurtured through the accumulation of various life experiences (Simonton, 2003) and that the nature of these experiences may be affected by school education, especially teacher behavior (Yeh & Wu, 2006). Teacher behavior is profoundly influenced by a teacher's professional knowledge (Borko & Putnam, 1995) and personal teaching efficacy (Aguirre & Speer, 2000; Albion, 2001). To enhance learners' creativity, therefore, teachers must develop these knowledge and belief in the context of the instruction of creativity.

Recently, the integration of knowledge management (KM) in instructional design has become an important pedagogical element in higher education. KM involves knowledge sharing, creation, validation, presentation, distribution, and application (Bhatt, 2001; Holm, 2001); it also emphasizes the integration of technologies (Gurteen, 1998; Schmidt, 2005). To date, few KM studies have focused on pre-service teachers' development of creativity instruction, although several studies have investigated the effects of integrating KM into curriculum design (e.g., Kidwell, Vander, & Johnson, 2000; Rees & Lu, 2009) or the effects of KM on professional development and self-efficacy (e.g., Endres, Endres, Chowdhury, & Alam, 2007; Fung, 2005; Sammour, Schreurs, Zoubi, & Vanhoof, 2008). Moreover, it has been found that a blended learning approach combining classroom instruction and e-learning is more effective than a pure e-learning approach (Osguthorpe & Graham, 2003).

Two questions, therefore, have emerged from these trends. First, can a teacher training program based on KM theories enhance pre-service teachers' professional knowledge and personal teaching efficacy of creativity instruction in a blended learning environment? Second, if the training program is effective, what are the mechanisms underlying this success? This study, therefore, aimed to develop a KM-based training program in a blended learning environment and examine its effects on pre-service teachers' professional knowledge and personal teaching efficacy relative to their teaching of creativity. Further, this study sought to explore the underlying mechanisms that would contribute to the success of this KM-based training.

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2. KM and its relationship to blended learning

2.1. Definitions of KM

Numerous definitions of KM have been proposed, and three major approaches for studying KM (technological, organizational, and ecological) have been developed. The technological approach focuses on tools that can be used to enhance knowledge sharing and creation. For example, Mahesh and Suresh (2004) defined KM as the strategic management of people and knowledge representations in an organization using specific technologies and processes to optimize knowledge sharing. A study from the American Productivity and Quality Center (AP & QC) also stated that organizations generally require a suitable IT infrastructure to implement KM strategies (AP & QC, 1997). In the organizational approach, organization design and workflows are optimized. Gurteen (1998) described KM as an emerging set of principles that govern organizational and business process design, as well as specific processes, applications, and technologies that help knowledge workers apply their creativity to achieve specific goals. In the same vein, Hult (2003) defined KM as the organized and systematic process of generating and disseminating information, as well as using explicit and tacit knowledge to achieve a competitive advantage in the marketplace. Finally, the ecological focus emphasizes interactions between people, identity, knowledge, and environmental factors. Hasanali (2002) pointed out that the keys to successful knowledge management can be divided into five major categories: (1) leadership; (2) culture; (3) structure, roles, and responsibilities; (4) information technology infrastructure; and (5) measurement. The interactions between these elements allow the success of KM.

Although the emphases of KM vary depending on the specific perspective taken, three components are common to all of these approaches: people, processes, and technology. In a school setting, KM can be defined as the process of knowledge sharing and creation via technology, in which learners first organize and internalize explicit knowledge into tacit knowledge and then convert tacit knowledge to explicit knowledge via interactions among different "ecological" systems.

2.2. The SECI model

The well-known SECI model, first proposed by Nonaka (1991), describes how explicit and tacit knowledge is generated, transferred, and recreated in organizations. More specifically, the SECI model consists of four modes of knowledge conversion: socialization (tacit to tacit), externalization (tacit to explicit), combination (explicit to explicit), and internalization (explicit to tacit) (Nonaka, 1991). "Socialization" is the process of sharing tacit knowledge through observation, imitation, practice, and participation in formal and informal communities. Socialization usually begins with building a field or space of social interaction. "Externalization" is a process of articulating tacit knowledge-as-explicit concepts; this is the key to knowledge creation. "Combination" is the process of integrating concepts into a knowledge system to integrate multiple bodies of explicit knowledge. Finally, "internalization" is the process of embodying explicit knowledge into tacit knowledge (Nonaka & Takeuchi, 1995).

Accordingly, the SECI emphasizes the dynamics of transforming the tacit/explicit interplay into novel products. These processes are complex and important for learning. In teacher education, KM should focus on how to help teachers identify, create, represent, distribute, and enable the adoption of good teaching practices in collaborative settings. The SECI should be a good model for teacher training.

2.3. KM and blended learning

Blended learning, which combines classroom instruction with e-learning, can maximize the benefits of both face-to-face and online methods (Osguthorpe & Graham, 2003). According to Dziuban, Hartman, and Moskal (2004), blended learning refers to a redesign of the instructional model with the following characteristics: (1) a shift from teacher-centered to student-centered instruction in which students become active and interactive learners; (2) increased student-instructor, student-student, student-content, and student-outside resources interactions; and (3) integrated formative and summative assessment mechanisms for students and instructors. These characteristics make blended learning very effective. It has been found that the use of blended learning in teacher training programs could effectively improve pre-service teachers' critical-thinking skills, personal teaching efficacy, and professional knowledge of critical-thinking instruction (Yeh, 2008).

Schmidt (2005) pointed out that KM and e-learning both aim to facilitate learning within organizations, but via two different paradigms. The main difference between KM and e-learning is that the former assumes knowledge can be actively produced or transferred, while the latter assumes that learning needs to be improved through guidance. Although these two learning approaches may appear to be contradictory from certain perspectives, they can be complementary when the blended learning approach is employed. In other words, guided practice or scaffolding can be integrated into the KM approach to enhance knowledge production and knowledge transfer through both face-to-face and online interactions.

3. KM and professional development of creativity instruction

3.1. Professional knowledge and personal teaching efficacy in creativity instruction

It is assumed that teachers' practice is based on their professional knowledge (Borko & Putnam, 1995). This professional knowledge can be developed by adopting learning theories and achieving "an eclectic compromise formed by selecting aspects of opposing theories and taking a position somewhere among them so as to form a mosaic pattern" (Bigge & Shermis, 1999, p. 2). Two types of professional knowledge are required for effective teaching, namely, content knowledge and pedagogical content knowledge (Bigge & Shermis, 1999; Shulman, 1987). Based on theories of teaching (Shulman, 1987) and creative thinking (e.g., Amabile, 1996; Cropley, 2000; Csikszentmihalyi, 1999; Fleith, 2000; Lubart & Getz, 1997; Mellou, 1996; Runco, 1996; Simonton, 2000; Sternberg & Lubart, 1999; Yeh, 2004), we have defined "content knowledge" in creativity instruction as a teacher's understanding of creative thinking, the prerequisites of a good creative thinker, and the factors that influence the development of creativity. In contrast, "pedagogical content knowledge" refers to a teacher's understanding of how

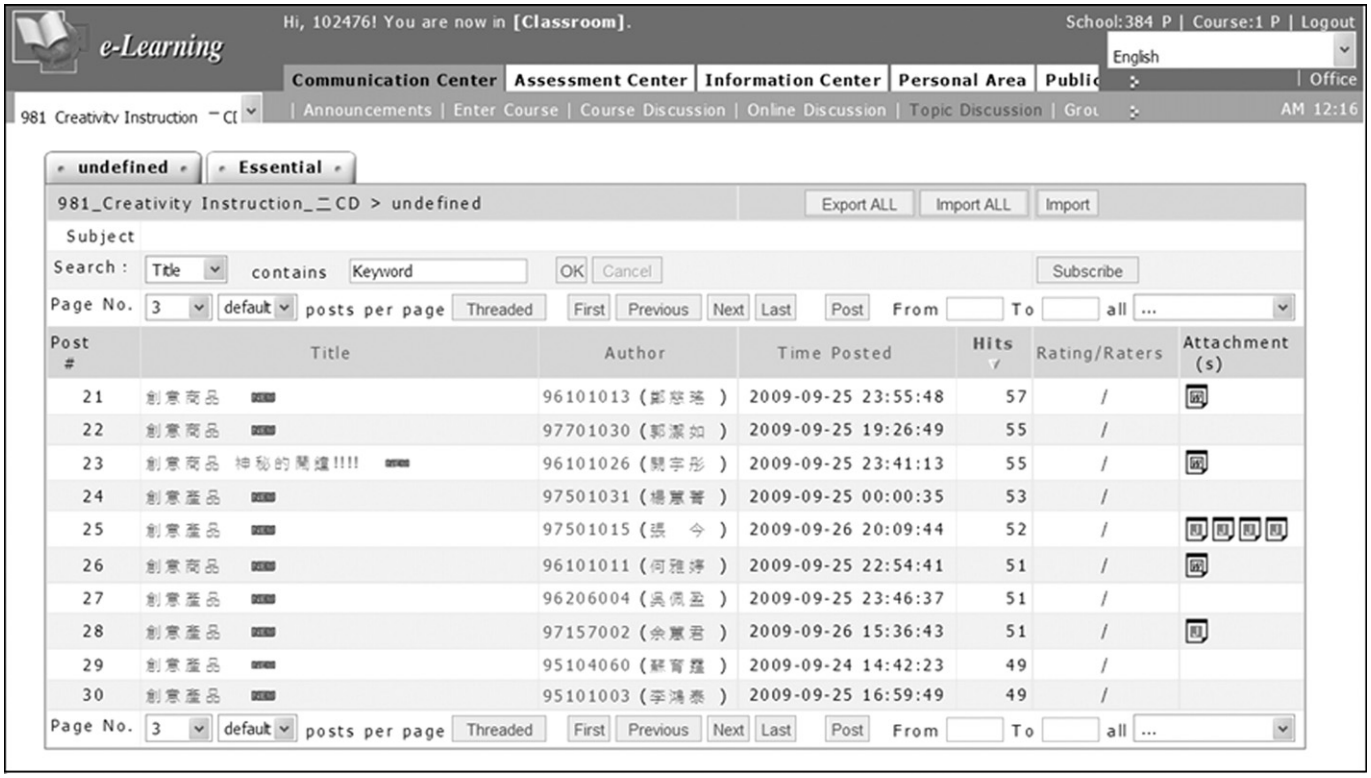

Fig. 1. A sample topic discussion page.

to design a curriculum to teach students creative thinking, how to select the most effective pedagogies for imparting creative-thinking skills, how to best employ effective teacher behaviors in the classroom, and how to assess students' creativity.

Another important factor, teacher efficacy, comprises teaching efficacy and personal teaching efficacy (Gibson & Dembo, 1984). Teaching efficacy refers to a teacher's belief that his or her ability to bring about change is limited by external factors, while personal teaching efficacy refers to a teacher's belief that he or she has the competence to bring about student learning. Some studies have suggested that teacher

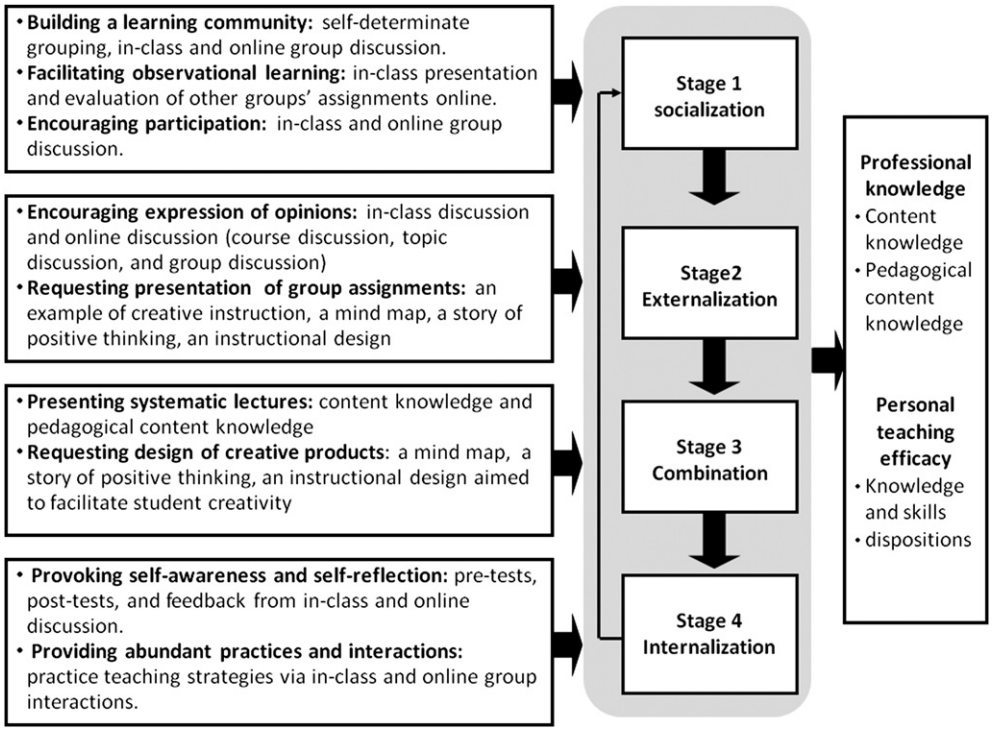

Fig. 2. The experimental instruction design.

Table 1
Participants' mean scores and standard deviations on the IPK-CI.

Factor	Pre-test			Post-test		
	N	*M*	*SD*	*N*	*M*	*SD*
Likert-type scale						
PK1[a]	33	3.409	.850	33	4.144	.857
PK2[b]	33	2.576	1.056	33	4.015	.817
Writing						
PK1	38	18.052	7.454	38	34.816	12.535
PK2	38	7.710	6.982	38	33.329	15.762

[a] content knowledge.
[b] pedagogical content knowledge.

efficacy is also closely related to teachers' commitment to teaching, adoption of innovations, and employment of effective classroom strategies (Aguirre & Speer, 2000; Albion, 2001; Kulinna & Silverman, 2000). To make pre-service teachers more efficacious, some researchers (e.g., Bandura, 1997; Tillema, 2000) have suggested that guided practices and reflective teaching should be incorporated into teacher training programs; moreover, increasing self-awareness and encouraging mindful learning enhances reflective teaching (Titone, Sherman, & Palmer, 1998).

Creativity is the result of interactions between an individual's knowledge, dispositions, and skills (Yeh, 2004). For example, Runco, Nemiro, and Walberg (1998) declared that a sound base of knowledge was the most important factor for the development of creativity and that the ability to build new schemas is important for knowledge building. Simonton (2000) found that creative people generally have independent and unconventional personality traits as well as broad interests, openness to new experiences, conspicuous behavioral and cognitive flexibility, and exhibit risk-taking behaviors. Moreover, Feldhusen (1995) claimed that creative thinking is a metacognitive process in which the abilities to plan, monitor, and evaluate cognitive operations are required. Accordingly, personal teaching efficacy in creativity instruction should be defined as a teacher's belief that he or she can improve these traits and skills in students.

3.2. KM, professional knowledge, and personal teaching efficacy in creativity instruction

To date, few studies have investigated the relationship between KM and teacher efficacy, although several have focused on the connection between KM and professional development in management (e.g., Fung, 2005) and education (e.g., Sammour et al., 2008). In particular, Sammour et al. (2008) suggested that KM can be used to capture, organize, and deliver knowledge within management systems and can therefore be an effective tool for educational training. However, the relationship between KM and teacher efficacy has not yet been determined. Several studies have suggested that that self-efficacy could enhance KM performance (Endres et al., 2007; Lai, 2009) although few reports have shown that KM can reinforce self-efficacy (Louise & Rachna, 2009). Louise and Rachna (2009) developed an ETK model (emotional, technological, and knowledge competence) and integrated it into KM. Their results suggested that self-efficacy can be influenced by intervention and treatment. According to the aforementioned suggestions and findings, it can be inferred that a KM system with deliberate instruction design can be an effective tool for improving pre-service teachers' professional knowledge and personal teaching efficacy in creativity instruction.

4. Hypotheses of this study

The major purpose of this study was to develop a KM-based training program in a blended learning environment and examine its effects on pre-service teachers' professional knowledge and personal teaching efficacy relative to their teaching of creativity. Secondarily, the study aimed to explore the underlying mechanisms that contributed to the success of this KM-based training. Two hypotheses were proposed: (1) The KM-based training program would improve pre-service teachers' professional knowledge in creativity instruction. (2) The KM-based training program would improve pre-service teachers' personal teaching efficacy in creativity instruction.

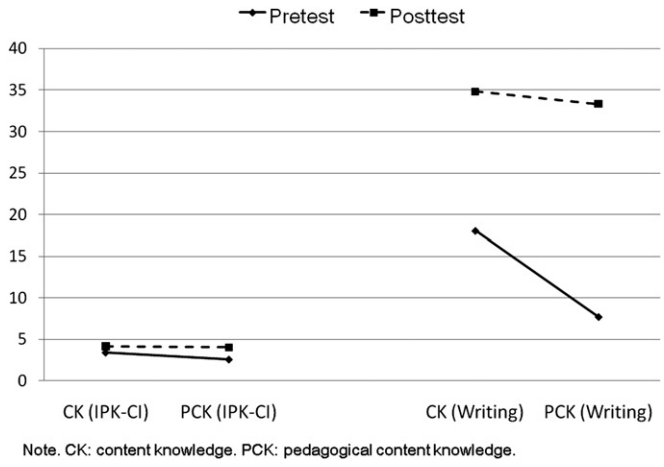

Fig. 3. Mean scores of the IPK-CI. Note. CK: content knowledge. PCK: pedagogical content knowledge.

Table 2
Analyses of simple main effects on professional knowledge (Likert-type scale).

Source	Type III SS	*df*	*MS*	*F*	Sig.	η^2
Pre-test						
Pk1[a] vs. Pk2[b]	11.458	1	11.458	50.720	.000	.613
Post-test						
Pk1 vs. Pk2	.274	1	.274	4.362	.045	.120
PK1						
Pre-test vs. Post-test	8.910	1	8.910	14.259	.001	.308
PK2						
Pre-test vs. Post-test	34.186	1	34.186	45.696	.000	.588

[a] content knowledge.
[b] pedagogical content knowledge.

5. Method

5.1. Participants

The participants were 44 pre-service teachers (9 males and 35 females) who were enrolled in a "Creative-Thinking Instruction" course offered by a two-year program for secondary school teachers in Taiwan. The mean age of the participants was 21.30 ($SD = 4.14$).

5.2. Instruments

The instruments employed in this study were the NCCU e-learning platform (http://wm3.nccu.edu.tw/learn/index.php), the *Inventory of Professional Knowledge in Creativity Instruction* (IPK-CI), the *Inventory of Personal Teaching Efficacy in Creativity Instruction* (IPTE-CI), and a reflective questionnaire. The NCCU e-learning platform consisted of an Information Center, Assessment Center, Communication Center, Personal Area, and Public Zone. The instructional design in this study required participants to complete a series of group assignments based on the SECI model, so it was expected that the Topic Discussion and Group Discussion pages in the Communication Center would be the most commonly used interfaces. Fig. 1 shows an example of the Topic Discussion page.

Both the IPK-CI and the PTE-CI were developed by the researchers and designed as a 6-point Likert scale with response options ranging from "totally disagree" to "totally agree". The results of factor analysis indicated that the IPK-CI comprised two factors: "content knowledge" (4 items) and "pedagogical content knowledge" (4 items). The total variance explained was 67%. The Cronbach's α coefficients for the IPK-CI and the two factors were .88, .79, and .85, respectively. Moreover, the correlation of the two factors were $r(71) = .67$, $p < 0.01$. Within the teachers sampled in this study, the explained variance was 75%. The Cronbach's α coefficients for the IPK-CI and the two factors were .96, .96, and .90, respectively. Moreover, the correlation of the two factors were $r(33) = .91$, $p < 0.01$. In addition, each of the IPK-CI items requested the participants to describe his or her knowledge related to the item. This written portion was scored on a 100-point scale in order to check the participants' professional knowledge. For example, the test item "I can clearly define creativity." was accompanied by a request to define creativity.

The results of factor analysis also indicated that the IPTE-CI was composed of two factors: "knowledge and skill improvement" (7 items) and "disposition improvement" (5 items). The total variance explained was 58%. The Cronbach's α coefficients for the IPTE-CI and the two factors were .90, .85, and .84, respectively. The correlation of the two factors was $r(71) = .69$, $p < 0.01$. Within the teachers sampled in this study, the explained variance was 66%. The Cronbach's α coefficients for the IPTE-CI and the two factors were .93, .90, and .88, respectively. The correlation of the two factors was $r(43) = .77$, $p < 0.01$. The test items included statements such as "I believe that I can make students active creative thinkers through my classroom teaching."

Finally, a reflection questionnaire consisting of five open-ended questions was developed to address the research goals of this study. The questions and their responses summarized are shown in the results section.

5.3. Experimental design and procedures

This study employed a before-and-after design. A 17-week experimental instruction program integrating the SECI model and blended learning was employed and administered by the first researcher. Pre-tests were given in the first week and post-tests were completed in the 17th week. The pre-tests included only the IPK-CI and the IPTE-CI, whereas the post-tests also included the reflection questionnaire. In the

Table 3
Analyses of simple main effects on professional knowledge (writing).

Source	Type III SS	*df*	*MS*	*F*	Sig.	η^2
Pre-test						
Pk1[a] vs. Pk2[b]	2032.224	1	2032.224	79.210	.000	.682
Post-test						
Pk1 vs. Pk2	42.003	1	42.003	.923	.343	.024
PK1						
Pre-test vs. Post-test	5339.066	1	5339.066	95.620	.000	.721
PK2						
Pre-test vs. Post-test	12469.766	1	12469.766	99.001	.000	.728

[a] content knowledge.
[b] pedagogical content knowledge.

Table 4
Participants' mean scores and standard deviations on the IPTE-CI.

Factor	Pre-test			Post-test		
	N	*M*	*SD*	*N*	*M*	*SD*
PTE1[a]	40	4.083	.725	40	4.489.	.542
PTE2[b]	40	4.010	.634	40	4.380	.573

[a] knowledge and skill improvement.
[b] disposition improvement.

second week, the participants were divided into eight groups of their own choosing and asked to complete a series of group assignments in the following weeks. The instructional goals of the first stage (from weeks 1–6) were to enhance the participants' self-awareness of their professional knowledge and personal teaching efficacy via the pre-tests, as well as to enhance their content knowledge and personal teaching efficacy via guided explorations of the concept of creativity, the prerequisites of a good creative thinker, and the factors that influence creativity development. The instructional goals of the second stage (from weeks 7–17) were to further improve the teachers' pedagogical knowledge through scaffolding techniques and to enhance their personal teaching efficacy in creativity instruction. This was achieved through multiple practical applications of creativity instructional strategies in both classroom and online settings. In both stages, corresponding lectures were given to achieve the instructional goals.

More specifically, the instructional design was based on the SECI model including socialization, externalization, combination, and internalization. The major corresponding teaching strategies employed in each process were as follows: (1) socialization: building a learning community, facilitating observational learning, and encouraging participation; (2) externalization: encouraging expression of opinions and requesting presentation of group assignments; (3) combination: presenting systematic lectures and requesting design of creative products; (4) provoking self-awareness and self-reflection as well as providing abundant practices and interactions. More details of instructional activities are shown in Fig. 2. Notably, blended learning was emphasized in this instructional design; class discussions followed online discussions. All topic discussions were graded in order to facilitate online dialogue. The topic discussions included discussions of creative products, creative instructions, mind maps, and stories of positive thinking. In addition, the dynamics of the SECI processes were emphasized; for example, most of the group assignments required the participants to experience all four process of SECI.

5.4. Data analysis

Several Repeated Measure Analyses of Variance were performed to evaluate the effects of the designed program on improvements in the participants' professional knowledge and personal teaching efficacy in creativity instruction. Moreover, content analysis was employed to determine the underlying mechanisms of the instructional effects as stated in the reflection questionnaires. Content analysis was conducted by two trained doctoral students. These researchers first independently reviewed the records and generated initial checklists of categories and concepts. Then they compared notes and revised the initial checklists, after which they created a consolidated checklist. The consolidated checklist was used to independently apply coding, and the consistency of the coding was checked. When inconsistencies occurred, discussions were conducted to reach a consensus.

6. Results

6.1. Improvements in professional knowledge of creativity instruction

Table 1 and Fig. 3 depict the participants' mean scores in the IPK-CI. For the Likert-type scale, a Repeated Measure Analysis of Variance yielded a significant Test (pre-test vs. post-test) × Factor (content knowledge vs. pedagogical knowledge) interaction effect, Wilks' $\Lambda = .462$, $p = 0.000$, $\eta^2 = .538$. The following analyses found that all simple main effects were significant. Specifically, the participants scored higher in content knowledge than in pedagogical content knowledge on both the pre-test and the post-test, $F(1, 32) = 50.720$, $p = 0.000$, $\eta^2 = .613$ and $F(1,32) = 4.362$, $p = 0.045$, $\eta^2 = .120$, respectively. Moreover, the participants scored higher on the post-test than on the pre-test in both

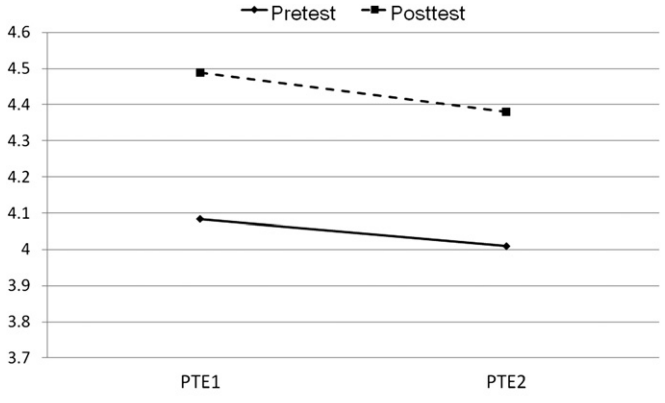

Fig. 4. Mean scores of the IPTE-CI. Note. PTE1: knowledge and skill improvement. PTE2: disposition improvement.

Table 5
Multivariate tests on personal teaching efficacy.

Source	Wilks' Λ	F	Hypothesis df	Error df	Sig.	η^2
Test	.685	17.909	1.000	39.000	.000	.315
Factor	.889	4.867	1.000	39.000	.033	.111
Test × Factor	.993	.288	1.000	39.000	.594	.007

content knowledge and pedagogical content knowledge, $F(1, 32) = 14.259$, $p = 0.001$, $\eta^2 = .308$ and $F(1,32) = 45.696$, $p = 0.000$, $\eta^2 = .588$ (see Table 2).

For the written portion, a Repeated Measure Analysis of Variance also yielded a significant Test (pre-test vs. post-test) × Factor (content knowledge vs. pedagogical content knowledge) interaction effect, Wilks' $\Lambda = .598$, $p = 0.000$, $\eta^2 = .402$. The following analyses showed that the participants scored higher in content knowledge than in pedagogical content knowledge on the pre-test, $F(1, 37) = 79.210$, $p = 0.000$, $\eta^2 = .682$. Moreover, the participants scored higher on the post-test than on the pre-test in both content knowledge and pedagogical knowledge, $F(1, 37) = 95.620$, $p = 0.000$, $\eta^2 = .721$ and $F(1,37) = 99.001$, $p = 0.000$, $\eta^2 = .728$ (see Table 3).

6.2. Improvements in personal teaching efficacy in creativity instruction

Table 4 and Fig. 4 depict the participants' mean scores on the IPTE-CI. The Repeated Measure Analysis of Variance yielded significant main effects of Test (pre-test vs. post-test) and Factor (knowledge and skill improvement vs. disposition improvement), Wilks' $\Lambda = .685$, $p = 0.000$, $\eta^2 = .315$ and Wilks' $\Lambda = .889$, $p = 0.033$, $\eta^2 = .111$. Comparisons of means showed that the participants scored higher on the post-test ($M = 4.435$) than on the pre-test ($M = 4.047$) and that the participants exhibited higher efficacy in improving students' knowledge and skills ($M = 4.286$) than in improving students' dispositions ($M = 4.195$). No significant Test × Factor interaction effect was found, Wilks' $\Lambda = .993$, $p = 0.594$, $\eta^2 = .007$ (see Table 5).

6.3. Mechanisms for improving professional knowledge and personal teaching efficacy

Five open-ended questions were included in a reflection questionnaire to further explore the underlying mechanisms that contributed to the effectiveness of the experimental instruction. Content analyses based on the participants' responses were analyzed and the frequency of each response was calculated. The results of these content analyses are presented in Table 6–Table 10.

Q1: This class integrated e-learning with classroom instruction. Did such an instructional design contribute to the improvement in your professional knowledge in creativity instruction? How?

Sixty-six percent of the participants indicated that the blended learning instructional design contributed to their professional knowledge. The primary benefits of e-learning (37%) were improvements in making digital products and providing opportunities for observational learning and knowledge sharing. Meanwhile, the benefits of classroom instruction (48%) were derived from lectures on instructional theories, strategies of instruction and creative thinking, and examples of these theories. Thirty-four percent of the participants reported that the instructional design did not effectively improve their professional knowledge, mostly because they felt that more practice in real classroom settings was required (7%) (see Table 6).

Q2: What do you think about producing a digital teaching material for creativity instruction?

Sixty-four percent of the participants reflected positively on this assignment. Most of the participants responded that this assignment contributed to their ability to apply the learned teaching strategies (29%) and to integrate theory and practice (15%). Those who did not appreciate this assignment (36%) indicated that their creativity was limited by a lack of experience in generating digital products (13%) and the restrictions presented by the time and assignment format (10%) (see Table 7).

Q3: This class integrated e-learning with classroom instruction. Did such an instructional design contribute to the improvement in your confidence in creativity instruction? How?

Table 6
Q1 content analysis.

Response	Frequency	%
Agree or not		
Yes	27	66
No	14	34
Total	41	100
Reasons (Yes)		
Contribution of e-learning	17	37
Improvements in making digital products (film making, mind mapping, instructional design)	9	20
Opportunities for observational learning and knowledge sharing	8	17
Contribution of classroom instruction	22	48
Lectures on instructional theories	10	22
Strategies for instruction and creative thinking	9	20
Examples of theories (films, picture books, etc.)	3	7
Reasons (No)		
More practice in real classroom settings was required	3	7
The e-learning platform only functioned as an interface for submitting assignments	2	4
The e-learning platform did not stimulate creativity	2	4
Total	46	100

Table 7
Q2 content analysis.

Response	Frequency	%
Feedback		
Positive	27	64
Negative	15	36
Total	42	100
Reasons underlying positive feedback		
Application of the learned teaching strategies	14	29
Integration of theories with practice contributed to future teaching skills	7	15
Stimulation of creative performance	4	8
Creation of shared memory with group members	3	6
Practice of oral presentations	2	4
Development of tacit understanding among group members	2	4
Opportunity to demonstrate creativity	1	2
Reasons underlying negative feedback		
Creativity is limited by a lack of experience in generating digital products	6	13
Creativity is limited by restricted time and assignment format	5	10
Do not understand students' background in the future	2	4
Not confident in practicing it during instruction	1	2
Could not grasp the key concepts for making an instructional design	1	2
Total	48	100

Eighty-five percent of the participants responded that the instructional design contributed to improvements in their personal teaching efficacy. The primary benefits of this design primarily came from online peer evaluation and the sharing of group assignments (56%), feedback from pre-tests and post-tests (12%), and the application of creative strategies (12%). However, 15% of the participants reported that this instructional design did not contribute to improvements in their personal teaching efficacy, either because they lacked reflective thinking habits (5%) or because they experienced limited improvement of their personal creativity (2%) (see Table 8).

Q4: This class integrated e-learning with classroom instruction. Did it enhance knowledge sharing and creation? How?

A significant majority of the participants (85%) agreed that this instructional design enhanced their knowledge sharing and creation. While knowledge creation was derived mainly from online discussions (12%), knowledge sharing seemed to come primarily from the sharing and evaluation of group assignments (57% and 5%). Among the 15% who disagreed that this instructional design was effective, only a few participants preferred the pure classroom instruction (2%) (see Table 9).

Q5: The term assignment requested all groups to make an instructional design focused on a subtopic under the topic decided by the class. What do you think about this assignment?

Most participants (85%) supported this design because it deepened their understanding of the common topic (57%), provoked self-reflection (17%), and enhanced knowledge integration (12%). A few participants (2%) responded that some subtopics were not broad enough. These subtopics were voted on by the participants, however (see Table 10).

7. Discussion

Two hypotheses were proposed in this study to test whether KM-based training in a blended learning environment could improve pre-service teachers' professional knowledge and personal teaching efficacy related to creativity instruction. Both hypotheses were supported by the significant effects yielded from Repeated Measure Analyses of Variance and positive responses in the reflection questionnaire. More specifically, the analytical results in this study showed that the designed training program based on the integration of the SECI model and blended learning was effective in improving the pre-service teachers' professional knowledge (especially content knowledge) and personal teaching efficacy pertaining to their teaching of creativity.

This study applied specific instructional design concepts in each stage of the SECI model. In the socialization stage, the participants were asked to build a learning community, engage in observational learning, and participate in both the class and online group discussion. These activities allowed the participants to share their tacit content knowledge and pedagogical knowledge. In the externalization stage, the

Table 8
Q3 content analysis.

Response	Frequency	%
Agree or not		
Yes	35	85
No	6	15
Total	41	100
Reasons (Yes)		
Online peer evaluation and sharing group assignments	23	56
Feedback from pre-tests and post-tests	5	12
Application of creative strategies	5	12
Homework	3	7
Group discussions	2	5
Reasons (No)		
Lack of reflective thinking habits	2	5
Limited improvement of personal creativity	1	2
Total	41	100

Table 9
Q4 content analysis.

Response	Frequency	%
Agree or not		
Yes	34	85
No	6	15
Total	40	100
Reasons (Yes)		
Knowledge sharing		
Sharing group assignments	24	57
More knowledge sharing than knowledge creation	7	17
Evaluation of group assignments	2	5
Open access to online information	1	2
Knowledge creation		
Online discussions	5	12
Reasons (No)		
Classroom discussions and lectures would be more beneficial	1	2
Online discussions were not active enough	1	2
Opinion sharing was not knowledge sharing	1	2
Total	42	100

participants were encouraged to express their opinions in-class and online discussions. Moreover, the participants were requested to present group assignments that allowed them to practice teaching strategies for creativity instruction. The participants thus articulated their tacit knowledge-as-explicit concepts, strengthening their professional knowledge and personal teaching efficacy. In the combination stage, the instructor first presented systematic lectures of content and pedagogical content knowledge and then requested that the participants design creative products. The designed products included a mind map, a story of positive thinking, and a lesson plan designed to facilitate student creativity. Through these activities, the participants were able to organize the presented concepts into their knowledge systems, further enhancing their personal teaching efficacy. Finally, in the internalization stage, the participants' self-awareness and reflection on their professional knowledge and personal teaching efficacy were stimulated by feedback from the pre-tests and post-tests and feedback from in-class and online discussions. In addition, there were abundant opportunities for the practice of teaching strategies via in-class and online group interactions. These activities allowed the participants to gradually internalize their professional knowledge and personal teaching efficacy. To validate the effectiveness of the SECI model and to further understand the underlying mechanisms of its success, a reflection questionnaire was employed at the end of the experimental instruction. The major findings of the reflection questionnaire were as follows: (1) While e-learning contributed more to the acquisition of pedagogical knowledge, classroom teaching brought about more benefits in teaching content knowledge. (2) The production of digital teaching materials contributed to the application of the learned teaching strategies, the integration of theories with practice, and the stimulation of personal creativity. (3) The enhancement of personal teaching efficacy came from online peer evaluations, observational learning, group discussions, the application of creative strategies, homework, and feedback from the pre-tests and post-tests. (4) While knowledge creation arose mainly from online discussions, knowledge sharing came primarily from observational learning and the open access to online information. (5) Co-creation of knowledge in the term assignment contributed to knowledge building, sharing, and integration as well as self-reflection. Accordingly, the hypotheses regarding the effectiveness of the SECI-based design in this study seem to be well-supported.

The findings in this study also support the suggestion that technology plays an important role in the practice of KM strategies. For example, Gasson and Shelfer (2007) proposed a knowledge-as-process perspective of knowledge management and suggested that information technology (IT) provides practical support for this strategy. In addition, Cartelli (2007) found that integrating SECI with Information and Communication Technology (ICT) can improve student learning, knowledge construction, and meaningful learning.

The SECI model has been validated by several researchers (e.g., Nonaka & Takeuchi, 1995; Nonaka, Byosiere, Borucki, & Konno, 1994). Empirical studies based on this model, however, are still being developed. The findings in this study support the claim that KM can be an effective tool for educational training (Sammour et al., 2008) as well as the argument that the means of access to knowledge, the means of knowledge production, and the forms of knowledge publication are important factors in improving teachers' professional development. The

Table 10
Q5 content analysis.

Response	Frequency	%
Feedback		
Positive	34	85
Negative	6	15
Total	40	100
Positive feedback		
Deepened understanding on the common topic	24	57
Provoked self-reflection	7	17
Enhanced knowledge integration	5	12
Enhanced responsibility for cooperation	2	5
Provided opportunities to learn from peers with varied expertise	1	2
Negative feedback		
Some subtopics were not broad enough	1	2
Knowledge became fractional	1	2
Topics should match those in future instruction	1	2
Total	42	100

findings in this study also suggest that a teacher's development of professional knowledge shares the same process of knowledge creation presented in the SECI model, i.e., the transition from tacit knowledge to explicit knowledge. The SECI model, therefore, is suitable for teacher training and especially for improving teachers' professional knowledge.

The close association between teacher efficacy and professional development has been confirmed by many studies (e.g., Aguirre & Speer, 2000; Albion, 2001; Kulinna & Silverman, 2000). The findings in this study are in line with other studies showing that self-efficacy can be enhanced by the KM system with deliberate instruction design (e.g., Louise & Rachna, 2009). In addition, the significant instructional effects support the suggestion that providing guided practice, increasing self-awareness, encouraging mindful learning, and provoking reflective teaching can help pre-service teachers become more efficacious (Tillema, 2000; Titone et al., 1998).

8. Conclusion and suggestions

Effective knowledge management, which is characterized by knowledge sharing and creation, is a key component of professional development in all knowledge-based careers. Nevertheless, knowledge management is still only rarely applied in teacher training programs. This study therefore has developed a KM-based training program that integrates the SECI model and blended learning to improve pre-service teachers' professional development with respect to creativity instruction. Both quantitative and qualitative analyses not only support the effectiveness of this instructional design but also illustrate the underlying mechanisms that contribute to improvements in pre-service teachers' professional knowledge and personal teaching efficacy. A well-designed program that integrates the SECI model and blended learning can improve pre-service teachers' professional knowledge and personal teaching efficacy pertaining to the instruction of creativity. Moreover, blended learning, guided practice, observational learning, group discussion, peer evaluation, and feedback are important mechanisms for enhancing knowledge sharing and creation, which further improve professional knowledge and personal teaching efficacy. Accordingly, the SECI model and blended learning may be integrated to create a new paradigm for teacher training. Due to the difficulty of setting up separate control and experimental groups of pre-service teachers, this study employed a before-and-after design. To compensate for this disadvantage, both quantitative and qualitative methods were employed; the highly consistent findings of these two approaches suggest that the findings in this study are reliable and valid. The application of integrating knowledge management theories into a blended learning environment in teacher education requires more empirical practices, and future studies should develop more KM-based teaching or training models to enhance the effectiveness of both learning and instruction. Finally, in addition to inventories and reflective questionnaires, this study also conducted some tests to measure pre-service teachers' improvements in professional knowledge of creativity instruction and provided practices of applying learned knowledge from the blended process to simulated teaching activities. Future studies can add follow-up studies to investigate whether improvements resulted from blended learning training will influence pre-service teachers' teaching of creativity in real classroom situations.

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