Fostering EFL teachers' CALL Competencies Through Project-based Learning

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ABSTRACT

Project-based learning (PBL), a learning-by-doing practice, has been used for enhancing English as a Foreign Language (EFL) students' language skills. However, the extent to which and how EFL teachers develop or improve Computer-Assisted Language Learning (CALL) competencies while experiencing PBL remain unexplored. For this study an 18-week PBL project was designed to improve EFL teachers' CALL competencies. A total of 12 EFL prospective teachers were recruited to participate in a sequence of activities: class observations, group discussions, and the design of lesson plans. Pre- and post- TPACK (technological pedagogical content knowledge) surveys were administered to measure participants' improvement of CALL competencies. Qualitative data, including class observation notes, lesson plans, group discussion records, and reflective essays, were collected to triangulate and complement survey results. The survey results showed that the prospective teachers demonstrated higher levels of CALL competencies after the PBL project. Using the qualitative data, this study explicitly documented the benefits which prospective teachers may obtain and the problems they may face when participating in a PBL project. The findings can help future teacher educators understand how to design and implement effective teaching training for CALL competency development.

Keywords

Project-based learning, CALL competencies, Teacher training

Introduction

Many technological tools have been integrated into language teaching to enhance English as a Foreign Language (EFL) students' language skills. For example, information and communication technologies (ICTs), such as Twitter and Facebook, help overcome the scarcity of exposure to English in EFL contexts by enabling students to communicate with native speakers (Kim, 2011; Sun, 2010). Web-based tools, such as Google Docs, Wiki, and Blogs, have also been used by EFL teachers to create a collaborative learning environment for writing and reading (Arslan & Şahin-Kızıl, 2010; Lin & Yang, 2013; Lin & Yang, 2011; Marzban, 2011; Sato, Matsunuma & Suzuki, 2013; Tozcu & Coady, 2004; Tseng & Yeh, 2018; Vanderplank, 2010; Yaghoobi & Razmjoo, 2016; Zaini & Mazdayasna, 2014; Yeh, Tseng, & Chen, 2019). To effectively integrate these tools into language teaching, EFL teachers should possess Computer-Assisted Language Learning (CALL) competencies, which combine instructional and content knowledge with technological knowledge (Golonka, Bowles, Frank, Richardson, & Freynik, 2014; Hong, 2010; Jones, 2001; Liu & Kleinsasser, 2015; Yang & Wu, 2012). The three types of knowledge align with Mishra and Koehler's (2006) and Koehler and Mishra's (2008) technological pedagogical content knowledge (TPACK) framework, comprising the three fundamental knowledge bases of content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK), which provided a theoretical framework for this study. CK refers to the knowledge of the subject matter to be taught, including concepts, organizational frameworks and evidence for claims (Shulman, 1986). PK includes knowledge of learning theories, general classroom management skills, lesson planning, and student assessment. PK enables teachers to understand how students construct knowledge and use this understanding to implement instructional practices that scaffold students' learning. TK, which is not limited to understanding how to operate various technologies, includes knowledge of how to choose the right technologies to accomplish tasks in specific situations. CK, PK, and TK intersect with each other to form pedagogical content knowledge (PCK), technological content knowledge (TCK), and technological pedagogical knowledge (TPK) (see Figure 1). Therefore, the TPACK framework has been used by researchers (e.g., Liu & Kleinsasser, 2015) to understand teachers' technology integration competencies.

Although many teacher training venues such as conferences and workshops have been used to foster EFL teachers' Computer-Assisted Language Learning (CALL) competencies, most EFL teachers still have difficulty adapting technologies to their own teaching contexts (Lin & Lu, 2010; Teo, 2009; Wang, Ertmer, & Newby,

2004). Even in-service teachers equipped with high levels of technical knowledge find it difficult to develop appropriate technology supported teaching materials and activities for their classrooms (Jang, 2010), often because previous teacher training programs focused on delivering content, demonstrating skills, or employing instructional strategies without providing opportunities for hands-on experience with various technologies (e.g., Chao, 2015; Hong, 2010; Kim, 2011). An effective teacher training program should provide teachers with experiences in which they practice combining teaching content, teaching activities, and using technology tools for authentic teaching purposes (Debski, 2006; McNeil, 2013).
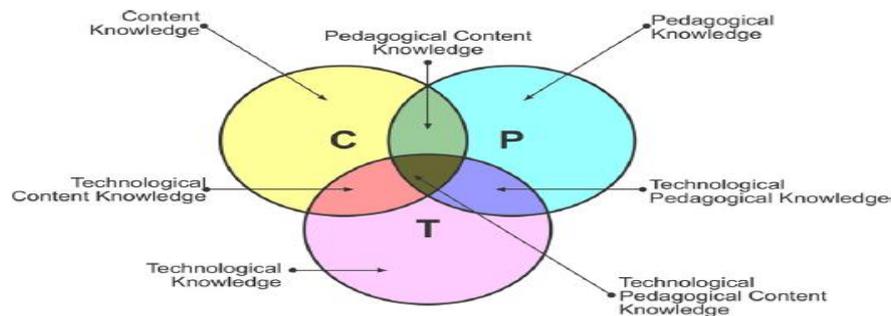

Figure 1. The TPACK framework (Mishra & Koehler, 2006)

One way to provide such experiences is to combine CALL with Project-based learning (PBL), a learning-by-doing practice in which teachers acquire knowledge through the design of usable artifacts such as lesson plans. This approach enables teachers to connect new knowledge to their own teaching contexts (Krajcik & Blumenfeld, 2006) and thus build connections among content, activities, and technology tools. However, only a few studies have investigated using PBL to develop teachers' CALL competencies and some caveats concerning the data in the investigation of PBL were identified. For example, Liu and Kleinsasser (2015) used self-reported data such as surveys and interviews to investigate the effects of PBL upon the development of teachers' CALL competencies, but the self-reported data could not capture how teachers develop CALL competencies and might not reveal teachers' actual CALL competencies. Therefore, the extent to which and how teachers develop or improve CALL competencies while experiencing PBL remains unexplored. To address this gap and seek ways to use PBL to support EFL teachers' CALL competency development, this study examined the effects of a PBL project featuring a sequence of activities including class observations, group discussions, lesson plan design, guided by the following research questions:

- What is the impact of a PBL project on the EFL teachers' CALL competencies?
- How do EFL teachers develop CALL competencies through PBL?

Theoretical foundation of PBL

PBL aligns with a constructivist view of learning, which advocates learning by collaboratively investigating and solving real-world problems. Three elements of PBL identified by Krajcik and Blumenfeld (2006), (1) generating driving questions, (2) developing artifacts, and (3) collaborating with peers, were adapted in designing the PBL project in this study. First, generating driving questions means that learners produced the questions to help them organize meaningful project goals and activities. Good driving questions are open-ended but feasible for learners to solve, relevant and important to their realities, and therefore interesting. Also in the case of inquiry, they provide worthwhile data (Krajcik & Blumenfeld, 2006). Poor driving questions have predictable outcomes, leaving no space for learners to explore alternatives, exercise judgment, and gain new insights and skills. One way to generate effective driving questions for teacher training is to engage teachers in class observations and stimulate their critical reflection on the problems of real-world teaching practices (Bell & Mladenovic, 2015).

Second, constructivist theory suggests that knowledge is not acquired through transmission but is developed through involvement in collaboratively developing artifacts to address the issues raised by driving questions. Developing artifacts involves learners in a series of activities including planning, searching for information, analyzing the information, and making products while sharing ideas with others (Blumenfeld, Soloway, Marx, Krajcik, Guzdial, & Palincsar, 1991). Such activities help learners build information literacy, problem-solving, and critical thinking skills (Garrison, 2007; Howard, 2002). Accordingly, to develop EFL teachers' CALL competencies and the ability to integrate technology into their teaching, participants in the present study were asked to develop a CALL lesson plan to address an observed teaching problem. The resulting artifacts were

expected to represent the teachers' emergent state of CALL competencies and their understanding of the driving question, which could inform further efforts to promote teachers' CALL competencies.

Finally, constructivist theory contends that collaboration plays a key role in knowledge construction because knowledge is developed and co-constructed with others rather than individually (Lave & Wenger, 1991; Wenger, McDermott & Snyder, 2002; Vygotsky, 1978). PBL provides the opportunity for teachers with different CALL competencies and teaching experiences to work together to solve teaching problems, sharing information and discussing and challenging ideas (Lin & Hsieh, 2001; Ward & Tiessen, 1997). Several studies have shown that collaboration enhances teachers' problem-solving abilities and willingness to undertake challenges and adopt new approaches in their classrooms (Cochran-Smith & Lytle, 1999; Hopkins, 2000; Van Horn, 2006). Collaboration can thus enable teachers to go beyond their current knowledge and build a shared understanding of effective CALL instruction.

A few empirical studies have examined whether PBL can be used effectively in EFL teacher education and some caveats concerning the data in the investigation of the PBL were identified. For example, Liu and Kleinsasser (2015) investigated how six vocational high school EFL teachers developed CALL competencies in a year-long technology-enriched professional development (TEPD) program, in which the teachers designed two WebQuest projects. The teachers learned about the theory and design of project-based instruction, discussed its implementation, and learned how to use a WebQuest procedure through a Moodle platform. A pre- and post-TPACK survey was administered to measure the improvement of their CALL competencies. The results showed that teachers achieved higher levels of CALL competencies through the analysis of pre- and post-TPACK surveys. However, the self-reported TPACK surveys might not accurately reveal teachers' CALL competencies learned through the PBL project, as there is usually some discrepancy between what individuals have reported on surveys and what they have actually done (Egbert, Paulus, & Nakamichi, 2002). In addition, the TPACK survey data itself could not capture how teachers developed CALL competencies throughout the PBL project. Other kinds of data should be collected to complement and validate survey data.

Methodology

Participants

The participants were a group of 12 prospective teachers majoring in an applied foreign language program and enrolled in an elective three-credit course, "Teaching children English," at a University of Science and Technology in central Taiwan. The objective of the course was to engage these prospective teachers in using technology to design a lesson plan for primary school students. Eight of the participants had no teaching experience, two had tutored English for one year, and two had tutored for two years, and all were in training to become certified English teachers. Participants were informed of the research procedures and data to be collected. All were given pseudonyms to ensure their anonymity.

Research design of this study: A PBL project

An 18-week teacher training course was designed to align with the three elements of PBL: driving questions, collaboration, and artifact development (Krajcik & Blumenfeld, 2006) (see Figure 2 and Table 1). First, to generate driving questions, the participants were divided into three groups to observe two English classes. Each group used a language classroom observation guide to document the strengths and weaknesses of the class and summarize two or three teaching problems that interested them. These teaching problems were then converted into the driving question of the group's PBL project.

Second, each group developed an artifact, a CALL lesson plan, to address the driving questions. As shown in Figure 2, the design of the CALL lesson plan involved the procedures of setting teaching objectives based on the driving questions, exploring a variety of online English teaching tools, selecting at least two online tools, and designing teaching activities based on the selected tools. These procedures were intended to help the participants to improve their CALL competencies. The CALL lesson plans designed by the participants were the artifacts that represented the emergent state of their CALL competencies and their understanding of the driving question.

Third, collaboration was implemented in this study through group discussions. Two rounds of online group discussions were conducted using Google Docs. In the first group discussion, which occurred right after the class observation, the members of each group reviewed their observation notes and identified lesson plan topics. The

second group discussion was held after the prospective teachers had received instruction in how teaching theories inform CALL pedagogical design for EFL learners. The goal of the second group discussion was for the prospective teachers to design teaching activities using technology tools. To facilitate each group discussions, a list of guiding questions was given to the participants, such as "What problems of English learning and teaching can you identify from your observations?" "What do you want students to learn from your lesson plans?" and "What are the instructional activities and tools that you will use in your project?" The participants discussed those questions with group members and kept records of their conversations in written form using Google Docs.
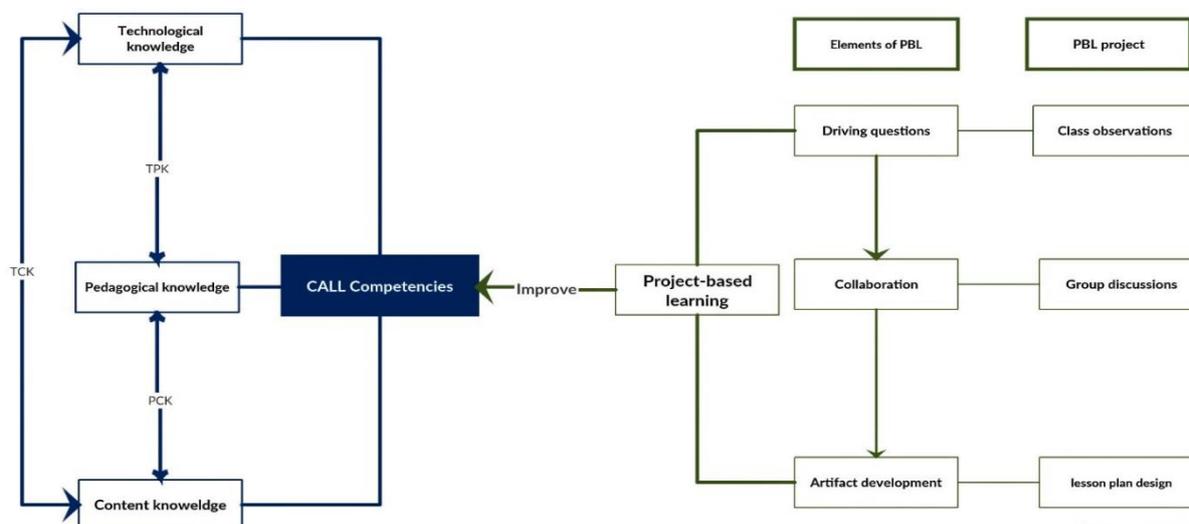

Figure 2. Design of the PBL project

Table 1. Timeline of the PBL project

Weeks	Activities	Collected data
Week 1	Taking pre-TPACK survey	Pre-TPACK survey
Week 2	Introducing the PBL project	None
Week 3	Observing an English class	Class observation notes
Week 4	Discussing class observations to generate driving questions	Group discussion records
Week 5	Observing an English class	Class observation notes
Week 6	Discussing class observations to generate driving questions	Group discussion records
Week 7-8	Designing a CALL lesson plan: Setting teaching objectives based on the driving questions through group discussions	CALL lesson plans Group discussion records
Week 9-11	Designing a CALL lesson plan: Searching and selecting online English teaching tools through group discussions	CALL lesson plans Group discussion records
Week 12-14	Designing a CALL lesson plan: Designing teaching activities based on the selected English teaching tools	CALL lesson plans Group discussion records
Week 15-16	Presenting the CALL lesson plan	CALL lesson plans Group discussion records
Week 17	Writing the reflective essays about the PBL project	Reflective essays
Week 18	Taking post-TPACK survey	Post-TPACK survey

In the final stage of the PBL project, the prospective teachers were asked to compose a 500- to 750-word reflective essay to describe what they learned from class observations, group discussions, and the design of lessons. The reflective essay was guided by seven open-ended questions, e.g., "How did the class observations improve your CALL competencies?" "How do you think your ability to use technology tools in teaching has improved after completing the PBL project?" and "Which of the PBL activities did you feel benefitted your CALL competencies the most? Please explain in detail."

Data collection and analysis

A mixed-methods design was employed to investigate how the PBL project improved prospective teachers' CALL competencies and which aspects had the most influence. The quantitative data were pre- and post-TPACK surveys. The qualitative data included reflective essays, class observation notes, group discussions, and lesson plans.

TPACK survey

The TPACK survey, administered before and after the PBL project, was used to investigate the impact of the PBL project upon prospective EFL teachers' CALL competencies (Research question 1). The survey was adapted from Schmidt, Baran, Thompson, Mishra, Koehler, and Shin's (2009) instrument, designed to measure "teachers' understanding of and self-reported ability to apply the domains of TPACK throughout their teacher preparation programs and in classrooms during practicum experiences" (p. 128). The survey comprised four items for collecting demographic information and 33 Likert scale items related to TK, CK, PK, PCK, TCK, and TPK. The 33 scale items together represented teachers' CALL competencies. To ensure the reliability of the 33 Likert scale items, Cronbach's (1951) coefficient alpha was calculated, and a value of .96 was obtained, indicating a highly reliable survey (Schmidt et al., 2009). The pre- and post-surveys were analyzed through the paired sample *t*-test.

Reflective essays, Class observation notes, Group discussions, and Lesson plans

Reflective essays, class observation notes, group discussion logs, and lesson plans complemented the TPACK survey data by providing qualitative data showing how the participants developed CALL competencies throughout PBL (Research question 2). An inductive approach (Creswell, 2013) was used to analyze the data, which included (1) organizing and reading through data, (2) coding the data, (3) generating themes, (4) interrelating the themes, and (5) interpreting the themes. The researchers started the analysis by reading through the reflective essays to discover emerging themes about the participants' class observations, group discussions, and the design of lessons. While reading the reflective essays, the researchers tagged interesting passages with one of four themes relevant to the research question 2: (1) teaching problems in English classes, (2) teaching topics in CALL lesson plans, (3) online English teaching tools, and (4) English teaching activities. The researchers then used the themes that emerged from the reflective essays to code the class observation notes, group discussions, and lesson plans and generated revised themes, which were broad enough to cover the ideas of the coded passages. The researchers arranged the themes in a network to visually represent their interrelationships. The researchers then interpreted the themes by drawing inferences, constructing explanations, and suggesting conclusions, which are presented in the sections of results and discussion.

Results

Teachers' progress in their CALL competencies after the PBL project

A paired-samples *t*-test was performed to examine participants' CALL competencies before and after the PBL project. The independent variable was the PBL project. The means and standard deviations for the prospective teachers' CALL competencies are shown in Table 2, which indicates that there were significant pre and post differences in TK $t(10) = -3.35$, CK $t(10) = -2.86$, PCK $t(10) = -2.58$, TCK $t(10) = -3.19$, TPK $t(10) = -4.56$, and overall CALL competencies $t(10) = -3.61$. However, there was no significant difference in PK $t(10) = -1.32$, $\eta^2 = .40$, although the participants scored higher in PK in the post survey. The effect size (Eta Square, η^2) was calculated to examine the magnitude of difference when a significant difference was observed. Based on Cohen (1992), the effect size of .20, .50, and .80 denote small, medium, and large effect sizes respectively. The results showed a large effect size in the TK, $= 1.01$, CK, $\eta^2 = .86$, PCK, $\eta^2 = .78$, TCK, $\eta^2 = .96$, TPK, $\eta^2 = 1.37$, and overall CALL competencies, $\eta^2 = 1.09$. Based on the descriptive and paired-sample *t*-test results, the researchers concluded that the prospective teachers significantly improved their CALL competencies overall and in TK, CK, PCK, TCK, and TPK after the PBL project.

Table 2. Descriptive and paired-samples *t*-test for the differences between pre and post CALL competencies survey

CALL competencies	Pre		Post					
	Mean	SD	Mean	SD	t	df	Sig.	η^2
TK	3.95	1.12	5.01	.89	-3.35	10	.007	1.01
CK	4.35	1.11	5.56	.77	-2.86	10	.017	.86
PK	4.66	.85	5.07	.76	-1.32	10	.215	.40
PCK	4.67	.98	5.34	.69	-2.58	10	.027	.78
TCK	4.31	.87	5.30	.77	-3.19	10	.010	.96
TPK	4.16	.97	5.35	.80	-4.56	10	.001	1.37
CALL	4.34	.71	5.10	.65	-3.61	10	.005	1.09

Developing CALL competencies through PBL

An 18-week PBL project was implemented to improve 12 prospective English teachers' CALL competencies based on the three features of PBL: driving questions, collaboration, and artifact development. This section describes how the prospective teachers developed CALL competencies through the PBL project.

Generating driving questions from class observations

The class observations were implemented to enable the prospective teachers to generate focused driving questions by witnessing actual teaching problems that arose in English classes. The class observation notes show that two essential teaching problems were observed by the prospective teachers. The first was that students of different levels of language proficiency were in the same class, making it difficult to meet the learning needs of each individual student. Several prospective teachers observed that nearly one third of the students were low-achievers, who shared that they sometimes could not understand what teachers were saying in English or their English textbooks. The second problem was that many students had low levels of motivation and participation. The prospective teachers observed that some students were completely disengaged and talking among themselves when they were supposed to be participating in activities because these activities consisted largely of mechanical drills that did not allow students to use their creativity to practice what they learned. Based on the two teaching problems, the prospective teachers proposed two driving questions: "How can teachers make teaching materials comprehensible for students of different language proficiency levels?" and "How can teachers enhance students' learning motivation?"

Developing artifacts through CALL lesson plan design

The prospective teachers worked in groups to design CALL lesson plans as final projects to address the two driving questions mentioned above. The design of CALL lesson plans comprised the procedures of (a) identifying topics of CALL lesson plans, (b) selecting online English teaching tools, and (c) designing teaching activities based on the selected online teaching tools. Three CALL lesson plans, one by each group, were developed (see Table 3). The three CALL lesson plans and prospective teachers' group discussion records were analyzed to determine how the prospective teachers went through the procedures of CALL lesson plan design.

Table 3. Three CALL lesson plans

Topics	Teaching objectives	Activities	Online teaching tools
Classroom	Reading	Memory games	Popplet
		Crossword puzzles	YouTube
Storymaking	Writing	Story writing	BBC-School Radio
	Speaking	Lyrics writing	Pinky Dinky Doo
		Nursery rhymes singing	Story Starter
SuperHero	Reading	Vocabulary recognition	PBSKids
	Listening	Story listening	

Identifying topics of CALL lesson plans based on the driving questions

The prospective teachers determined the topics of their CALL lesson plans based on the driving question of how to enhance students' learning motivations. To solve the driving question, the prospective teachers proposed that teaching topics of CALL lesson plans should be designed in relation to students' life experiences. For example, the prospective teachers in Group A suggested that "classroom" was an interesting topic for students, because the classroom was a space in which students spent a good part of their lives and their classroom experiences gave them vocabulary to practice in daily life. Similarly, Group B's discussion records show that to make lesson plan topics relevant to students' life experiences, the prospective teachers intended to allow students to choose topics of their own. The two discussion records demonstrated that the driving questions derived from observing English classes were latter used by the prospective teachers as references to identify the topics of CALL lesson plans.

> Cindy: What's our topic? Everyone! Give a topic.
> Lisa: I think the topic about classroom is ok.
> Sean: I think we can talk about supermarkets.
> Cindy: Why do you want to teach the topic of classroom?
> Lisa: Because a classroom is a place where the students spend time almost every day.
> Sean: And they can use the everyday vocabulary they learn about classrooms.
> Cindy: So the topic is close to their daily life! I love the idea. So we all agree with the topic?
> Sean: Yes (Group A discussion records)
>
> Nina: Any ideas about lesson plan design?
> Jack: How about story making? We can ask students to create stories.
> Nina: Good idea. But what are the possible topics?
> Alice: I think we can allow students to choose their own topics? Students may feel more motivated in writing stories on their own.
> Jack: I agree. We can also list three to five topics for less proficient students to choose if they have no ideas. So those students will not feel overwhelmed (Group B discussion records).

Selecting online English teaching tools

After identifying CALL lesson plan topics, the prospective teachers proceeded to the selection of online tools to use in CALL lesson plans. A total of six online tools, including *Popplet, YouTube, BBC-School Radio, Pinky Dinky Doo, Story Starter*, and *PBSKids*, were incorporated by the prospective teachers into CALL lesson plans. These teaching tools were purposefully selected to address the driving question of how to make learning materials comprehensible for students at different language proficiency levels. Therefore, the selection criteria for the online tools called for a multimedia environment in which students could comprehend texts through contextual information including visual and audio cues. In the selection process, the prospective teachers found that many open educational websites and tools with kid-friendly visual and audio components were available online to support the learning of English and other subjects. However, they also pointed out that selecting appropriate educational tools from the Internet was not a simple task but rather required them to evaluate the pros and cons of the educational tools based on the value of the activities for their teaching objectives and the tools' appropriateness for a particular group of students. Group A's discussion records, for example, demonstrated how the prospective teachers evaluated *Pinky Dinky Doo* and *Story Starters* for their CALL lesson plan. Nina asked Tim to evaluate which of the two storytelling websites would be better for their lesson plan. Tim preferred *Pinky Dinky Doo*, because its content and activities were easier than *Story Starters* for students whose native language was not English. However, Nina argued that *Pinky Dinky Doo* was not a good choice for it did not allow students to practice oral skills, which was one of the teaching objectives in their lesson plan. She suggested that they could have students practice both writing and speaking skills by asking them to write lyrics for a song based on the stories they created on *Pinky Dinky Doo*. As another example, Group C discussed the advantages of the use of *Popplet* and *YouTube* in English class. These examples revealed that the selection of online tools engaged the prospective teachers in analyzing and evaluating online educational resources, which improved their technological knowledge. The next section will describe how the prospective teachers integrated these online tools into their teaching activities.

> Nina: I've found some language teaching websites like Pinky Dinky Doo at http://www.pinkydinkydoo.com/storybox.html and Story Starter at http://www.scholastic.com/teachers/story-starters/ Which one do you prefer?
> Tim: The first one, Pinky Dinky Doo.

Nina: Yes, why do you want to choose Pinky Dinky Doo?

Tim: I think story-starters might be a little bit too hard for the kids. Because English is not our native language, Pink Dinky is easier for students. Pinky Doo is an exciting game. There are lots of fun stories to choose like horror stories, silly stories, fairy stories, etc. Students can complete the story by choosing different characters, background, etc. Another interesting thing about it is that you can learn new vocabularies. Pinky Dinky would give students the meaning of vocabulary, and read the text for students.

Nina: Do you think Pinky Dinky meets our objectives? I think we need to think about our objectives first. Basically, we want to motivate students to speak more in class. I think we can still use Pinky Dinky. But we need to change it a little. Maybe we can create a song without lyrics. Students need to write the lyrics for the song based on their stories. (Group B discussion records)

Cindy: I found a concept map tool, http://www.popplet.com/ What do you think?

Sean: This website is good. It can create a map that can help us make an outline. So students can know what they are going to learn in this class.

Lisa: We can describe our outline before we teach vocabulary. In addition, I also think that we can look for some songs that related to our teaching theme on YouTube. Music can draw students' attention and establish a pleasant learning environment.

Sean: That's right. We can find lots of songs or videos on YouTube.

Lisa: I think learning by songs can be more interesting. And we can sing with students (Group A discussion records)

Designing teaching activates based on the selected online tools

Based on the online tools they selected, the prospective teachers designed such activities as crossword puzzles, story writing, and nursery rhyme singing to help students improve English reading, listening, speaking, or writing skills. They used a concept map tool and YouTube links to combine vocabulary learning with a game. They created a map of themes, each of which was linked to a related You Tube video that gave clues to the words needed to fill in a crossword puzzle. For example, as shown in Figure 3, when students clicked on the theme "clothes," they would be linked to a YouTube video featuring a clothes song by Peter Weatherall, to which they would listen for clues to the adjacent crossword puzzle. After completing the activity, students would be expected to have learned the meanings, pronunciations, and spelling of the target vocabulary.

Figure 3. Vocabulary learning activities with technologies

Another group used *Pinky Dinky Doo* (see http://www.pinkydinkydoo.com/storybox.html) to improve students' writing skills. As Figure 4 shows, *Pinky Dinky Doo,* for example, provides students with six story genres. When they click on one, they find a blank story frame with five pictures on the left side and a short text below in which some vocabulary and phrases are left out. Students are asked to fill in each blank in the story by clicking on the appropriate picture on the left. As students fill out the story, they click on "read aloud" to listen to the story and watch the animations in order to move to the next part. After all the students have finished the Pinky Dinky Doo activities, they are given worksheets to write lyrics for a song based on the stories they made in Pinky Dinky Doo.

Click on one story type   Fill in the story blanks   Listen to and watch the story

Figure 4. Writing learning activities with technologies

Discussion

The purpose of this study was to investigate how prospective teachers' CALL competencies could be improved through participating in a PBL project. The results support previous research (Liu & Kleinsasser, 2015) which showed that PBL projects can help teachers develop CALL competencies. In addition, this study extended the existing literature by applying Mishra and Koehler's (2006) TPACK framework to explore whether participation in a PBL project improved CALL competences in the specific areas of TK, CK, PK, PCK, TCK, and TPK. The survey results indicated that the prospective teachers demonstrated significant improvement in all areas except PK, although post-survey scores were higher for this component too. PK refers to knowledge about learning theories and the design of teaching practices based on specific learning theories (Mishra & Koehler, 2006). The less significant improvement in PK might be explained by prospective teachers' attention to particular theories suitable to their lesson plans rather than to a broad range of learning theories. Thus they showed some PK gains, but these reflected their knowledge of only the particular theories with which they adopted in this project.

Apart from the pre- and post-surveys, the qualitative data, including class observation notes, group discussion transcripts, lesson plans, and reflective essays, which provided rich description of prospective teachers' actual processes of developing CALL competencies, were valuable complements to the self-reported TPACK survey results. Class observations were found to provide a crucial foundation for the development of CALL competencies through involvement in PBL projects. Being exposed to a situated learning environment stimulated the prospective teachers to generate driving questions and critically reflect on authentic teaching problems. The driving questions derived from observing real classrooms gave the prospective teachers a starting point for developing creative and student-centered ideas for integrating technology into language teaching. Liu and Kleinsasser (2015) found that in previous CALL training programs, teachers often confined themselves to the traditional use of technology by asking students to recite the content from online websites. The driving questions concerning low English learning motivation and multilevel classrooms stimulated the prospective teachers in this study to use the audio and visual features of online websites to keep students motivated to learn, and make learning contents personalized and comprehensible for students of different language proficient levels.

As the culminating activity of the project, the design of CALL lesson plans required the prospective teachers to explore online tools and integrate selected tools into teaching activities, which provided hands-on experiences that involved combining pedagogical, content, and technical knowledge required for CALL competencies. For example, echoing Vanderplank (2010), who studied applications of technology in language teaching, this study showed that selecting the right Internet resources to integrate into teaching was the major challenge facing the prospective teachers. Conflicts arose regarding individual preferences for specific technologies to use in teaching, and these forced the prospective teachers to debate the extent to which particular technologies met teaching objectives and could be adapted into particular teaching contexts. This process led the prospective teachers to increase their technological and instructional knowledge so they could articulate their reasons for claiming the effectiveness and viability of particular technologies in language teaching.

Although this study demonstrated the extent to which and how teachers developed or improved CALL competencies through the PBL pre-teacher training, there are some limitations. First, the prospective teachers did not implement the lesson plans they developed in real classrooms. Future studies might explore how pre-service or in-service teachers use their lesson plans in real teaching contexts, and ask them to reflect upon the effectiveness of their lesson plans. Second, this study did not require the prospective teachers to compose a CALL lesson plan before the PBL project for the purpose of pre- and post-project comparison, because the participants were the prospective teachers who did not have sufficient knowledge to design lesson plans before

the PBL project. Future studies may compare the lessons developed by the in-service teachers before and after the PBL to investigate changes in CALL competencies.

Conclusion

This study contributes to the CALL teacher education knowledge base by proposing a PBL project based on Krajcik and Blumenfeld's (2006) elements of PBL to improve EFL teachers' CALL competencies. The PBL project involved class observations, group discussions, and the design of lesson plans. The results showed that the prospective teachers demonstrated higher levels of CALL competencies after the PBL project developed for this study, which can provide a model for developing both pre-service and in-service EFL teachers' CALL competencies.

In addition, previous research relied solely on self-reported survey data to investigate the impact of PBL upon teachers' CALL competencies. This study extended the existing literature by qualitatively exploring additional data sources to investigate the processes by which teachers developed CALL competencies, including class observation notes, group discussion records, and lesson plans. Using these concrete artifacts, this study explicitly illustrated the benefits which prospective teachers may obtain and the problems they may face when participating in a PBL project. The findings can inform teacher educators' efforts to design and implement effective teaching training for CALL competency development.

Acknowledgments

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