The impact of problem-based learning on Chinese-speaking elementary school students' English vocabulary learning and use

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ABSTRACT

This study examined the impact of the problem-based learning (PBL) approach on English vocabulary learning and use in an elementary school in Taiwan. Two classes, each with 28 students, participated in the study. One class was assigned to be the experimental group and the other the control group. Both groups received the same learning content, but different instructional input. The experimental group used the PBL technique and learned the target vocabulary through learner-centered activities, while the control group used teacher lecture-based instructional techniques. All participants completed pre- and post-tests on vocabulary knowledge and wrote a topic-based composition and a self-report. The t-test results of the pre- and post-tests show that there were no significant differences between the two groups. However, the PBL group outperformed the non-PBL group in using the Off-List level of vocabulary in the writing task. The PBL participants also used a significantly higher proportion of vocabulary beyond the 2000-word level, and wrote significantly longer compositions than their counterparts. The PBL participants' self-reports suggest that PBL provided sufficient English conversation practice; it can be used to foster elementary school students' ability to learn and use vocabulary in context.

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1. Introduction

Vocabulary is considered essential to successful second/foreign language learning (Schmitt, 2000). Learners with a firm vocabulary foundation may experience an accelerated learning curve in later stages of language learning and perform the skills of listening, speaking, reading, and writing successfully. In addition, vocabulary serves as the foundation of real-life communication. The more vocabulary a learner understands, the more skillful expressions he/she can make. In the context of learning English as a foreign language (EFL), students have problems when learning English vocabulary. Students usually learn new English vocabulary by rote memorization, which often results in boredom (Min & Hsu, 2008). After being taught a significant set of vocabulary, most students fail to apply this knowledge appropriately in the situations in which they need to communicate, read, or write in English (Atay & Kurt, 2006; Barrow, Nakanishi, & Ishino, 1999; Hunt & Beglar, 2005). Many EFL learners believe that their most significant obstacle is learning vocabulary (Gordani, 2013). A common explanation for this phenomenon is the teacher-centered explicit lecture approach in vocabulary instruction. Much of what is taught with

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the explicit teacher–lecture method produces inert knowledge that is not easily applied in new situations (Ellis, 2003). Thus, these students lack the skills required to actively apply their learned knowledge to real-life scenarios. Language instructors need to apply teaching methods that facilitate the students' ability to efficiently construct vocabulary knowledge and to use it in daily communication, reading, and writing activities.

Problem-based learning (PBL) is an approach that motivates students to learn through involvement in a real problem. Students receiving PBL training simultaneously develop both problem-solving strategies and disciplinary knowledge bases. In a PBL classroom, the instructor usually proposes a problem; students assume a dominant role to create their learning plans based on the analysis of the problem. In the literature, PBL emphasizes that social interaction is pivotal to knowledge construction, acquisition, and application. This approach can also foster active engagement in knowledge construction (Bridges, 1992; Evensen & Hmelo, 2000; Hmelo, 1998). Moreover, this approach stresses a learning scaffold with which learners are supported by teachers and peers. Using the PBL approach, second language (L2) learners may explore vocabulary meanings through teamwork, and can formulate their own knowledge of proper vocabulary usage in real-life contexts. This knowledge construction process may guide these learners to realize the vocabulary meanings and usage in communication contexts. In the EFL context, empirical research examining the effectiveness of the PBL approach has been limited. Accordingly, the purpose of this study was to incorporate the PBL approach into an English course with the aim of engaging elementary school students in constructivist learning activities (Foote, Vermette, & Battaglia, 2001; Savery & Duffy, 1996; Simone, 2008), thereby enhancing their English vocabulary learning and use.

2. Literature review

2.1. Problem-based learning

PBL organizes the curricular content around problem scenarios. Bridges (1992) indicated that the PBL curriculum is characterized by the following features (pp. 5–6):

1. The starting point for learning is a problem (that is, a stimulus for which an individual lacks a ready response).
2. The problem is one that students are likely to face as future professionals.
3. The knowledge that students are expected to acquire during their professional training is organized around problems rather than disciplines.
4. Students, individually and collectively, assume a major responsibility for their own instruction and learning.
5. Most of the learning occurs within the context of small groups rather than lectures.

Given these characteristics, the problem addressed by the students is not just the starting point to activate a course, but is the centerpiece of this learning approach. The instructor prepares problems and applies them in class to guide the students' learning. The problems should not simply be related to the content of the material or involve questions on a quiz or test, but can be designed as a variety of situations and tasks. The process of working out solutions to various problems is similar to experiencing a chain of events. The more problems the students learn to solve, the more opportunities they will have to apply their knowledge to different events.

The PBL pedagogy shares some specific features with those emphasized by the task-based language teaching (TBLT) approach. TBLT stresses the development of language learners' communicative competence. Adopting this as a goal, the instructor designs tasks requiring two-way information exchanges to increase negotiation (Ellis, 2003; Johnson, 2003). In the literature, various definitions for the word *task* have been offered (for overviews, see Bygate, Skehan, & Swain, 2001; Ellis, 2003; Johnson, 2003; Van den Branden, 2006). From the perspective of general functions, the tasks designed for the classroom activities can be "the one hundred and one things people do in everyday life, at work, at play, and in between" (Long, 1985, p.89), such as describing people, making a restaurant reservation, and completing a form. Regarding communicative language teaching, a task is designed to facilitate language use. Van den Branden (2006) further indicated that "tasks are supposed to elicit the kinds of communicative behavior (such as the negotiation for meaning) that arises from performing real-life language tasks (p.9)". TBLT advocates have commented that tasks play an essential role in promoting second language acquisition. In line with TBLT, PBL requires a close link between the tasks performed by learners in the classroom and those conducted in the outside world. However, the main differences between TBLT and PBL are related to the presentation of the problem and the level of teacher guidance. The problem presentation serves as a primary defining feature to distinguish TBLT from PBL. In TBLT, tasks are descriptive. In PBL, the instructor initially proposes a problem. Subsequent teaching activities are centered on the problem. In each class meeting, the teacher asks the students to review the problem, establish a new goal, review their learning schedule, and further search for new data. The problem plays a role in provoking a constant cycle of editing, revising, rethinking, and reformulating (Spronken-Smith, 2005). In general, problems provide the basis for an entire language learning curriculum.

The PBL approach emphasizes a learner-centered curriculum in which instruction is regarded as the process of helping the learner to actively acquire knowledge, and to independently interpret and operate it within the real world. Savery and Duffy (1996) proposed a constructivist framework for a PBL instructional model, indicating that a learner's understanding is gradually constructed through active engagement with problems. The construction process entails learners "setting or

negotiating a goal, making plans, doing research, creating materials, evaluating them, and revising" (Alessi & Trollip, 2001, p. 33). Adopting a constructivist perspective, the PBL curriculum maintains that learners undergo individual interpretation of what they perceive, and actively construct knowledge in their long-term memory.

In addition, the PBL approach emphasizes the learner's social interaction (Savery & Duffy, 1996). Social negotiation of meaning is the core of the knowledge construction process. The effectiveness of L2 learning can be maximized when learners are actively engaged in social interaction, such as teamwork, group discussion, and interpersonal communication. Furthermore, the PBL approach emphasizes learning via scaffolding. Learners may benefit from the assistance and support of someone who is more knowledgeable than they are when learning something new. PBL proponents suggest that instructional designers create educational environments in which the teacher provides guidance and support, and the learner's knowledge construction is facilitated (Hmelo, 1998; Hmelo-Silver, 2004; Savery & Duffy, 1996; Tseng, Chang, & Lou, 2012). Teaching can be regarded as a true conversation between teacher and learner, the nature of which relationship is negotiable.

In a PBL classroom, the students work in groups. PBL has thus been found to promote collaborative teamwork that helps students to solve real-world problems (Hmelo-Silver, 2004; Peterson, 1997). In addition, PBL is effective in terms of enhancing students' inquiry skills to seek and evaluate the information they acquire (Hmelo & Ferrari, 1997), their reflection skills to think about learning during the learning process and to further develop their metacognitive ability (Peterson, 1997), and their ability to transfer skills and apply knowledge from the classroom to the real world (Dochy, Segers, Van den Bossche, & Gijbels, 2003; Hmelo-Silver, 2004; Hoffman & Ritchie, 1997; Stepien, Gallager, & Workman, 1993). However, controversy exists regarding whether a PBL approach can lead to better learning outcomes. For example, Colliver (2000) indicated that there was no convincing evidence that PBL improves medical students' diagnosis techniques. Spronken-Smith (2005) indicated that students did not develop transferable skills in oral communication. With these conflicting results in mind, the present study aimed to further investigate the effectiveness of PBL in terms of EFL learners' English learning. In addition, PBL has been used in a variety of discipline-related academic studies, including architecture, business, engineering, law, and science in universities (Alcazar & Fitzgerald, 2005; Boud & Feletti, 2003; Jenkins, Breen, Lindsay, & Brew, 2003). However, this method has not been widely investigated in the EFL context, especially in elementary schools. From the reviewed literature, the PBL approach is likely to enhance vocabulary use. This approach was therefore applied to teaching English vocabulary in an elementary school in Taiwan.

2.2. The need for an innovative approach to vocabulary teaching and learning

Vocabulary is a core component of language proficiency, and it provides much of the basis for how well learners speak, listen, read, and write (Atay & Kurt, 2006; Nation, 2008). Most situations in the real world are not as well-organized as those presented in the classroom. EFL learners likely confront a common difficulty that they cannot apply the vocabulary they have learned in the classroom to real-world situations. As Chen, Shih, and Liu (2015) noted, most learners thought that the English courses they took in the past had failed to prepare them to use English in real-life settings. Thus, using effective methods to foster learners' ability to use vocabulary is one of the major goals of second/foreign language learners.

Second/foreign language educators use various methods to foster vocabulary learning, such as explicit/intentional approaches (Kasahara, 2011; Nation, 2001), implicit/incidental approaches (Laufer, 2005; Laufer & Hulstijn, 2001), and a combination of explicit and incidental approaches (Pellicer-Sanchez & Schmitt, 2010; Schmitt, 2000; Sonbul & Schmitt, 2010). Explicit/intentional approaches emphasize that words are learned through direct instruction in which students learn words through systematic interpretation; in such approaches, the focus of the learning is the word itself. Explicit/intentional learning strategies include glosses, mnemonic devices, key words, and morphological and syntactic analysis. Such pedagogical approaches suffer the criticism of decontextualization and fail to improve learners' utilization of learned vocabulary. On the other hand, implicit/incidental approaches provide sufficient contextualized input and emphasize that vocabulary knowledge is acquired incidentally. Vocabulary is learned as a by-product of language learning activities; examples of such an approach include extensive and sustained reading activities. However, it is not easy for EFL learners to participate in such vocabulary learning strategies due to the lack of sufficient English resources and supportive English environments. Beginning learners with limited vocabulary and reading ability may not benefit from such vocabulary pedagogy. The concerns raised from the above two approaches are echoed by another research path in which language education professionals combine explicit and implicit approaches. This combination approach is validated by previous research (Hill & Laufer, 2003; Mondria, 2003; Sonbul & Schmitt, 2010).

In this study, vocabulary instruction incorporated the PBL approach and further synthesized explicit and implicit teaching strategies. In a PBL curriculum, explicit vocabulary instruction implemented in the beginning stage focuses on introducing new vocabulary. Furthermore, incidental vocabulary learning activities applied for the larger portion of time during this teaching period are targeted to inspire students' active and frequent utilization of target vocabulary. The PBL vocabulary instruction integrating both explicit and incidental teaching techniques is rarely discussed in the EFL context. Hence, the present study highlights this novel pedagogy to mend this gap in the literature.

2.3. Vocabulary knowledge assessment

Vocabulary knowledge can be discussed from various perspectives. The present study investigated vocabulary knowledge from the receptive-productive dimension, which is related to learners' knowledge of the meaning of a word and how they use

it in oral or written contexts (Ellis, 1994). Proposing three modes of vocabulary knowledge, Laufer (1998) defined the three types of knowledge as follows: (1) receptive knowledge is helpful for "understanding the most frequent and core meaning of a word"; (2) controlled productive knowledge "entails producing words when prompted by a task", such as cued recall; and (3) free productive knowledge is related to "the use of words at one's free will, without any specific prompts for particular words" (p. 257). The dimension of receptive-productive knowledge itself exists on a continuum (Read, 2000). For research analysis, it is difficult to define how and at what point words become available for productive use.

With the PBL pedagogical emphasis on the application of knowledge to solve real-life problems, as in the present study, vocabulary use in context has attracted the most attention. The present study adapted the vocabulary knowledge scale designed by Paribakht and Wesche (1997) to measure EFL learners' receptive and productive vocabulary knowledge. A detailed explanation of the scale is presented in the data collection section. As Agustín Llach and Barreras Gómez (2007) indicated, composition writing is an effective way to evaluate the learners' usage of vocabulary. This study further employed writing as an assessment tool to measure learners' vocabulary knowledge from a different angle. The collected writing was further analyzed using the lexical frequency profile (LFP). The LFP is a comprehensive measure of the range of vocabulary used in a written composition. Laufer and Nation (1995) claimed that it draws on a range of established word lists (Nation, 1986), and it has become a standard reference in L2 vocabulary studies. The validity and the reliability of LFP are discussed in the data analysis section.

According to the reviewed literature on the PBL approach, minimal attention has been paid to English language education. The present study investigated the potential of the PBL approach by examining its effects on students' vocabulary learning outcomes using elementary school pupils as the participants to fill the PBL research gap. The following questions were addressed:

1. Are there significant differences between the two instructional modes (the PBL approach and the non-PBL approach) in the vocabulary knowledge test?
2. Are there significant differences between the two instructional modes (the PBL approach and the non-PBL approach) in composition writing?
3. What are the participants' perceptions of teaching techniques and activities administered in the two instructional modes?

3. Methods

3.1. Research design

The intervention study had a pre-test/post-test control group design. Two intact classes were randomly assigned to either the PBL or the non-PBL condition. The vocabulary knowledge of the participants in both groups was measured with the vocabulary knowledge (VK) pre-test before the intervention to examine whether a significant difference existed between the two groups' knowledge of the target vocabulary. The VK post-test was administered two weeks after the treatment and used to compare the effects of the two instructional methods. After the post-test, all of the participants wrote a composition and a self-report.

3.2. Participants

The participants were 56 fifth grade elementary school students recruited from two classes in a public elementary school located in the northern part of Taiwan. They had received English instruction in school since the third grade. Their native language was Mandarin. The English teachers of both classes were Chinese native speakers with at least five years of teaching experience. Both teachers had graduated from a university in Taiwan and had received English teaching training. To bridge the differences between the two instructors and to provide scaffolding for the English course, the researcher offered them teaching plans, direction statements, and self-designed learning sheets for the two instructional groups.

The two classes were randomly assigned to be the experimental group (13 females and 15 males) and the control group (11 females and 17 males). The average age of the experimental group was 11 years and 3 months, while that of the control group was 11 years and 1 month.

3.3. Pedagogical intervention

All participants in the two conditions attended English classes that covered the same content and the same vocabulary. The duration of the treatments was 12 weeks. Both groups had two 40-min periods of English instruction each week. The instructional activity covered three units, Units 1, 2 and 3, each of which was instructed for a period of four weeks. In total, 17 vocabulary items were covered in the three units. Unit 1 included 5 items (*art, Chinese, English, math, music, and PE*), Unit 2 included 5 items (*get up, go home, go to bed, go to school*, and *do my homework*), and Unit 3, 6 items (*by bike, by bus, by car, by MRT, by scooter,* and *on foot*). For each unit, the instructor taught the target words in the first week and led the participants to repeatedly practice them in the remaining three weeks. Throughout the four weeks, the instructor presented all target words

of the unit on the blackboard in each class meeting. In general, both groups underwent the same sequence from the first section of the student book through to the last section. Both groups completed exercises in the workbook each week.

3.3.1. The treatment for the PBL group

The PBL group's one-week teaching scheme of Unit 1 is presented in Appendix A. As shown in the scheme, each week, the PBL curriculum started with a problem, and a systematic, learner-centered enquiry process was thereafter initiated. In accordance with the problem-based curriculum, the researcher further designed a question-and-answer (Q & A) activity that included a series of questions collected from the textbook and that was designed by the researcher (see Appendix A for examples of the questions). The instructor used the questions to guide free talk with the participants. These questions demanded less work than the problems proposed in the beginning of the section of learning a new unit. The students could answer the questions very quickly; however, to work out solutions to the problem, they were required to synthesize the information from different resources, namely the student book, the workbook, the learning sheet, and the teacher's demonstrations. Small-group discussions were held throughout the four-week instruction schedule. The students were divided into four groups of five students and one group of six. They had only two years of prior English learning experience, and therefore were limited in both their English skills and vocabulary. In the small-group discussion, they were encouraged to use English, but were allowed to use Mandarin to ensure effective discussion.

Due to the lack of earlier research on the application of the PBL approach in elementary school English instruction, this study generated six general steps for manipulating the PBL vocabulary instruction, as informed by Bridges (1992). During the instruction of each unit, the instructor first demonstrated the problem on the learning sheet, using Chinese to explain it, and interpreted the situations related to the problem. Second, the instructor introduced a list of the target vocabulary words together with their Chinese translations, and led the participants to practice spelling. Third, the instructor conducted the Q & A activity to lead free talk with the participants, and further demonstrated possible answers orally. Fourth, the participants of each group read the assigned material and the supplementary data, and discussed them to identify solutions to the problems. Fifth, each of the participants recorded his or her own solutions; then, the groups worked out a final solution and presented it. Sixth, the instructor synthesized the reports from each group and offered a general solution. In general, explicit vocabulary instruction was conducted during the second stage, and implicit vocabulary learning was launched during the other stages.

Throughout these six stages, all participants were encouraged to actively participate in vocabulary learning according to their English ability. For example, participants with limited English proficiency were asked to provide a one-word or short response, whereas those with a higher level of skill produced more complete sentences and participated in longer conversations with the instructor, or acted as model students responsible for presenting the solutions for their groups. Helman (2009) recommended that instructors encourage students to talk in class, leading them to actively construct knowledge and process the content being taught. The participants were thus encouraged to talk to each other in the small group activity and to practice conversation with the instructor.

3.3.2. The treatment for the non-PBL group

The control group, which was the non-PBL group, used the same student book, workbook and learning sheets, but was taught using the teacher lecture-based approach to vocabulary learning. The participants only received explicit vocabulary instruction. The instructor took responsibility for delivering the instruction, and did not propose problems or self-designed questions to initiate vocabulary learning; instead, she offered explanations of the target vocabulary and the sentences included in the research materials. For each unit, she started by displaying on the blackboard a list of the target words together with their Chinese translations, using Chinese to explain word forms, word parts, and the grammatical patterns into which the words fit. She then read aloud each item for the students to repeat, or would ask them to read aloud the target words. Third, the instructor led the students to read the conversation sample in the textbook, and pointed out the vocabulary embedded in the sentences, offering Chinese equivalents of words/phrases and further using Mandarin to explain the meanings of the sentences. She also provided grammatical explanations of how the words were used in the context of the sentences. Fourth, she led the participants to perform written and oral repetition of the vocabulary. At this stage, the participants were directed to memorize the word-translation pairs and to practice spelling. Fifth, she asked the participants to complete exercises in the student book and the workbook. Afterward, they completed the learning sheets.

3.3.3. English textbook

The English textbook was *Hi English*-5 (HESS, 2011), which was selected by the elementary school for their fifth grade students. It includes a student book and a workbook. Three units were selected as the research materials, coded as Units 1, 2, and 3. The topics were "What classes do you have on Monday?" (Unit 1), "What time do you go to school?" (Unit 2), and "How do you go home?" (Unit 3).

3.3.4. Learning sheets

The learning sheets were designed by the researcher and used as teaching materials for the two instructional groups; they differed in terms of the learning task directions. For the PBL group, the learning task was introduced by a problem accompanied with a series of questions (see Appendix A). Using Unit 1 as an example, the problem proposed on the learning sheet is: "If you were a teacher, what kind of weekly schedule would you like to give your students? Why?" To help the participants identify the solution to this problem, the instructor used a series of questions to stimulate free talk with them. The

participants in each group combined the answers to the questions with other sentences in the teaching materials to generate a coherent composition as a solution to the problem. The other two problems proposed in Units 2 and 3 were: "What is the schedule for you and your family on Sunday?" and "Mark comes from Canada and will visit Taiwan for one week. What is your travel plan for him?"

For the non-PBL group, the descriptive statement on the learning sheet and the teaching activity was as follows: "If you were a teacher, please design a one-week curriculum." The instructor directed the participants to complete the table by supplying the subject names, and asked a couple of participants to read the sentences aloud, such as "We have Music, Chinese, and English on Monday"; "We have two PE classes on Friday."

3.4. Data collection

3.4.1. The vocabulary knowledge (VK) pre- and post-tests

A VK test adapted from Paribakht and Wesche (1997) was employed to assess the participants' receptive and productive knowledge. The reliability of this scale was tested in Wesche and Paribkht's (1996) research, and a high level of consistency was shown in the students' responses to the 24 content words tested (pp. 31—33). In this study, the test consisted of 17 target vocabulary items, and was used as both the pre- and post-tests for both treatments. The test had a duration of 30 min, and the participants were not informed of the posttest in advance.

The scoring scale of Paribakht and Wesche (1997, cited in Read, 2000, p. 133) was adopted. For each vocabulary item, the participants checked one of the following categories:

I.   I don't remember having seen this word/phrase before.
II. I have seen this word/phrase before, but I don't know what it means.
III. I have seen this word/phrase before, and I think it means _____ (synonym or translation)
IV. I know this word. It means _____ (synonym or translation)
V.   I can use this word in a sentence: _____ (Write a sentence.)
     (If you complete this section, please also complete Section IV.)

Due to the participants' limited English proficiency, the categories were translated into Mandarin, based on Min and Hsu's (2008) study. As indicated by Read (2000), responses to Categories I and II were scored 1 and 2, respectively. An acceptable synonym or translation in Category III was scored 3. If the participant offered an appropriate translation for Category IV but did not write a sentence, a score of 3 was awarded. Scores of 4 and 5 were assigned for sentences written in response to Category V. A score of 4 was given if the target word fit the sentence context appropriately but was used in a grammatically incorrect way, while a score of 5 was awarded when the target word/phrase was translated appropriately and the sentence was written correctly. The maximum score was 85 points, and the minimum was 17. Inter-rater reliability was established to ensure the credibility of the scoring. The participants' responses in the pre- and post-tests were evaluated by the researcher and the research assistant, with an inter-rater reliability of 0.93 and 0.96, respectively.

A pilot study was conducted with 15 fifth grade elementary school students from another school, the results of which were used to modify the testing procedure and testing instructions. With 56 participants, the measure of reliability of the pre- and post-tests estimated by Cronbach's alpha was 0.96 and 0.97, respectively.

3.4.2. Topic writing

The topic was selected by considering the words presented in the three units, the participants' life experience, and the target vocabulary items. The genre selection was first based on the objective of the PBL curriculum in this study, developing the learner's ability to use English vocabulary in the real world, i.e., in communicative settings. Moreover, Agustín Llach and Barreras Gómez (2007) analyzed English vocabulary used by fourth grade Spanish students in primary education using letter composition as their data-collection instrument. They explained that children at this age were curious about other people and other cultures. When replying to a letter from a pen pal, the participants were likely to be engaged in communication outside of the classroom. In the same vein, this study adopted letter composition. A set of questions added in the letter was intended to elicit the target vocabulary of the three units (see Appendix B). The instructor reminded the participants to write as much as they could in the 30-min writing session.

3.4.3. Self-reports

The two groups of participants wrote down their perceptions of the instructor's teaching techniques, teaching activities, and recommendations for the English class.

3.5. Data analysis

The research questions concerned whether there were significant differences between the two instructional groups in the VK test and composition writing. The quantitative data collected from the VK pre- and post-tests and topic writing were statistically analyzed to answer the first and second research questions.

Regarding the VK pre- and post-tests, the mean score of each group was calculated by adding each participant's score of each test, with the totaled score being divided by the total number of each group. In addition, the two groups' writing protocols for *My Day* were analyzed using the LFP. The LEP was tested in several studies using short texts written by learners of English (Laufer, 1998; Laufer & Nation, 1995, 1999; Nation & Heatley, 1996). Moreover, the researchers argued that it might be possible to use this measure to estimate the size of non-native English speakers' productive vocabulary. A steady flow of research has utilized the LFP, with the outcomes published in widely disseminated journals (e.g., Cobb & Horst, 2001; Meara & Fitzpatrick, 2000; Morris & Cobb, 2004; Muncie, 2002). As further validation, Abbasian and Shiri's (2011) study involving 50 Iranian students indicated that it is a reliable measure of the lexical richness of EFL learners' written discourse. The present study therefore adopted the LFP to elicit the students' production of the target vocabulary. The LFP is available as a freely downloadable software program, Web-VocabProfile (2014), an adaptation of Heatley, Nation and Coxhead's (2002) *Range*. The LFP shows the word frequency (the percentage of the four categories and the two condensed categories) and text length (the total number of words) of a written protocol. The vocabulary of the participants' compositions was analyzed according to four frequency categories: (1) K1: the most frequent 1000 words of English, (2) K2: the second most frequent 1000 words of English, i.e. 1001 to 2,000, (3) AWL: the academic word list of English (the AWL, 550 words that are frequent in academic texts across subjects), and (4) Off-List: the remainder, which are not found in the other lists. The LFP data were further converted into a condensed profile consisting of the percentage of basic-2000 words (i.e., the sum of the scores of the first two lists) and the percentage of beyond-2000 words (i.e., the sum of the scores of the AWL and Off-List words).

Independent samples *t*-tests were conducted to examine between-group variances. The results of the *t*-tests showed whether significant differences were present between the two instructional groups in terms of prior vocabulary knowledge (the VK pre-test), vocabulary learning, and vocabulary use (the VK post-test, four levels of word frequency, two condensed word levels, and text length). The dependent variables were the two groups' mean scores of the VK pre- and post-tests and of the protocols collected from the topic writing; the independent variable was the instructional method: "PBL" and "non-PBL." The significance level was set at 0.05. In addition, self-reports, the qualitative data, were used to triangulate participants' learning performance and reflections. The self-report protocols were first screened out of the statements, illustrating teaching techniques and activities, and the frequencies were further calculated.

4. Results

4.1. The vocabulary knowledge pre- and post-tests

The VK pre-test scores for both groups were evaluated with an independent samples *t*-test. The result revealed that there were no statistically significant differences between the groups ($t = 0.183$, $p = 0.856 > 0.05$). The two groups' knowledge of the target vocabulary was thus similar prior to the treatment.

Table 1 presents the descriptive statistics results of the VK post-test, including the mean scores and SDs, and the results of the independent samples *t*-tests. In Table 1, the PBL group's mean scores on the three units and the totaled mean scores are consistently higher than those of the non-PBL group. However, the results of the *t*-test reveal that no significant differences were present between the mean scores or the totaled mean scores of the two groups for the three units (Table 1).

4.2. Topic writing

4.2.1. Four levels of word frequency and text length

Some participants did not complete this task, yielding 25 PBL and 22 non-PBL writing protocols. Table 2 summarizes the descriptive statistics of the LFP analysis. For both groups, the first category (K1) accounted for most of the participants' writing, and the AWL, the least. The 1000 most frequent words (K1) constituted approximately 84% and 87% of the PBL and non-PBL groups' compositions, respectively.

The two sets of compositions were compared using an independent samples *t*-test. In Table 2, there were no significant differences in the use of the first (K1), second (K2), or third (AWL) categories of words. These results reveal that both groups used the same proportion of 1000 and 2000 frequent vocabulary items and AWL vocabulary in the topic writing activity. However, there was a significant difference in the fourth category ($t = 2.369$, $p = 0.023$). That is, the PBL group outperformed the non-PBL group in using the Off-List vocabulary.

Table 1
T-test results of the PBL and non-PBL groups' mean scores on the VK post-test.

Unit	PBL ($n = 28$)		Non-PBL ($n = 28$)		t	p
	Mean	SD	Mean	SD		
Unit 1	21.89	5.43	20.82	5.09	.761	.45
Unit 2	18.43	4.86	17.36	4.68	.84	.404
Unit 3	21.54	5.70	19.18	6.47	1.447	.154
Total	60.86	14.91	57.36	14.76	1.135	.261

Table 2
Means and SDs of the PBL and non-PBL groups' LFP.

	PBL ($n = 25$)		Non-PBL ($n = 22$)		t	p
	Mean	SD	Mean	SD		
K 1	84.23	4.02	86.50	4.33	−1.852	.071
K 2	8.82	3.84	8.73	3.64	.081	.936
AWL	.213	.75	.197	.52	.088	.93
Off-List	6.74	2.76	4.58	3.41	2.369	.023
Text length	73.92	25.73	52.86	17.08	3.34	.002

Note. K 1 = the most frequent 1000 words; K 2 = the most frequent 2000 words; AWL = the academic word list of English, and Off-List = the remainder which are not found in the other lists.

Regarding text length, the PBL group's mean score was significantly higher than that of the non-PBL group ($t = 3.34$, $p = 0.002$), with the PBL participants writing significantly longer compositions.

4.2.2. Basic-2000 words vs. beyond-2000 words

Table 3 presents condensed profiles of the PBL and non-PBL groups. The 1000 and 2000 most frequent words constituted approximately 93% and 95% of the PBL and non-PBL groups' compositions, respectively, while the AWL and Off-List words constituted approximately 7% and 5%.

Significant differences were present at the level of the basic-2000 words and beyond-2000 words between the two groups (Table 3). Congruent with the significant result of the PBL group's use of Off-List vocabulary noted in the previous section, the PBL group used a significantly higher proportion of beyond-2000 vocabulary in the writing activity ($t = 2.34$, $p = 0.024$). On the other hand, the non-PBL group used a significantly higher proportion of basic-2000 words ($t = -2.34$, $p = 0.024$). The finding suggests that the PBL approach effectively improve the participants' ability to use the beyond-2000 words.

4.3. Self-reports

All 28 participants in the PBL group expressed that they enjoyed having English conversations with their teacher in class, which allowed them to receive sufficient opportunities to practice their speaking abilities. One participant expressed that the teacher was nice to provide him the answer when he was speechless in the Q & A activity. Two stated that the questions in the Q & A activity stimulated their curiosity and motivated them to actively work out and learn the answers. Another participant expressed that she learned how to implement the words in complete sentences, despite the fact that her sentences are still grammatically flawed, providing her practice with the actual language usage. Ten participants reported that they enjoyed studying English in the small group. Among them, one participant stated that she felt a more interactive dynamic within her group, where her group members worked very hard and loved exchanging information with each other. Another participant felt that the small group activity was very helpful in enhancing his English level because the group leader would help him when he had no idea how to represent his thoughts and experiences in words and writing. Furthermore, another participant enjoyed discussing with her small group after class, studying at the library, and receiving additional help from her classmates in terms of writing the answers.

Of the 28 non-PBL self-reports, six mentioned that they appreciate the sufficient time allotted to practice the words and sentences given by their teacher; two of them gave positive reviews of the clear and detailed explanations of the exercises in the workbook. Three participants further expressed that these rules and exercises had assisted them in the memorization task. One participant described that he liked to read aloud the sentences in class because the teacher corrected his pronunciation and demonstrated the pronunciation of target words. One participant mentioned that she practiced spelling frequently out of class, but three expressed that they never reviewed the words at home. However, five participants who attended language cram schools felt bored with such rule interpretations and drill exercises.

5. Discussion

Regarding the VK post-test, the *t*-test result of the two groups fell short of significance. It therefore appears that vocabulary learning can be regarded as part of the wider tradition of the psychological perspective on the role of

Table 3
PBL and non-PBL groups' condensed profiles of LFP.

	PBL ($n = 25$)		Non-PBL ($n = 22$)		t	p
	Mean	SD	Mean	SD		
K 1 + K 2	93.05	2.94	95.23	3.37	−2.345	.024
AWL + Off-List	6.95	2.94	4.77	3.37	2.344	.024

memory in language processing. The participants in the two instructional conditions performed almost equally well in terms of recognizing and memorizing the translation of words. This is probably because the non-PBL instruction focused on rote memorization to commit these target items to memory; consequently, most of the non-PBL participants were able to achieve a score of 3 or 4, indicating that they had seen or knew these items and were able to provide correct translations.

Regarding the topic writing activity, both groups exhibited different significant outcomes of vocabulary learning. This can be attributed to the different vocabulary teaching approaches conducted in the two groups. In the non-PBL group, the instructor used a direct teacher-based approach. Instruction focusing on the word itself is essential for successful L2 vocabulary acquisition (Nation, 2001). This explicit instruction helped the non-PBL participants to memorize and use the basic-2000 words well. In contrast, a combination of explicit and incidental approaches was adopted with the PBL group. In line with the perspectives expressed in Sonbul and Schmitt's study (2010), some forms of explicit and implicit manipulation do have an impact on vocabulary learning.

The PBL approach integrated with a combination of both vocabulary instruction techniques tended to significantly improve the participants' ability to use the vocabulary at the level of beyond-2000 words and to result in longer compositions than their counterparts produced. These findings provide empirical support for the PBL pedagogy, and can be explained as follows. First, the emphasis on interpersonal communication in the PBL treatment may have been the key to productive compositions. Armed with the influential role of social and cultural context in learning and knowledge construction, L2 learners' thinking and meaning-making is socially constructed and gradually emerges from their interactions within the socio-cultural environment of the home, community, and classroom. From the constructivist perspective, Savery and Duffy (1996) further proposed that "[k]nowledge evolves through social negotiation and through the evaluation of the viability of individual understandings" (p.136). Moreover, Atay and Kurt (2006), in a study with Turkish elementary school EFL learners, administered group work in their experimental treatment, which resulted in significantly higher scores on a vocabulary test than in the control group. They attributed this to the socially interactive learning that occurred in the small collaborative groups. In the present study, the PBL participants were divided into small groups to devise solutions to problems, during which period each group member frequently had conversation with the other members and expressed their answers in spoken or written form. In this way, PBL participants likely practiced composing a longer discourse than their counterparts.

The discussion is likely to have played a role in assisting the PBL participants to write significantly longer compositions than their counterparts. Hoffman and Ritchie (1997) indicated that "knowledge elaboration takes place through team discussion" (p. 99). During the process of discussion, the participants might have exchanged opinions with each other, monitoring their own understanding and examining the understanding of others. Such negotiation would have stimulated new learning of the target words. The participants might have confronted target words used in the sentences that were different from those in the student book or the workbook. The knowledge of using the target words in sentences could be progressively constructed through discussion. Furthermore, in such an interactive and communicational environment, each participant likely had more opportunities to discuss the problems from various angles than their non-PBL counterparts. The significant outcomes of the PBL group's topic writing suggest that the PBL approach fostered the participants' ability to express their opinions more completely.

The productive outcomes of the topic writing can also be attributed to problem scenarios. The problems designed for the PBL group formulated scenarios for situated practice of the target vocabulary. When analyzing the problem, the learners may have identified the relevant facts from the scenario, and this fact-identification step helped them to represent the problem (Hmelo-Silver, 2004). As shown in Appendix A, the teaching activities were structured around problems. During the problem-solving process, the learners could play out the scenario in their minds and seek propositions that were compatible with the specific scenarios. This process might have guided them to use the target words in a holistic discourse. Consequently, the participants had the chance to practice writing compositions, rather than just producing isolated sentences or spelling the words.

Regarding the PBL participants' significant use of the beyond-2000 words, prior knowledge may be a key factor. PBL researchers concur that PBL promotes learning by drawing on learners' experience and prior knowledge, as well as involving them in social interaction (Bridges, 1992; Hmelo-Silver, 2004; Savery & Duffy, 1996). Only when new information is closely connected with prior knowledge or information that the learner has already mastered can learning occur (Foote et al., 2001). In this study, the problems and questions were generated to connect with the participants' past and present experiences. The instructor used the Q & A activity and free talk to help the participants to recall their previously-acquired vocabulary, and to introduce and practice the target vocabulary. The new words were also used in the sentence patterns that they had learned. In this way, new words could be understood through their linkage to known concepts and likely became intimately connected with the participants' own experience and prior knowledge.

Instructional support and scaffolding may also explain the PBL participants' significant use of the beyond-2000 words. Children's learning can be facilitated by peers, teachers, and others around them in the community. In the Q & A activity, the teacher frequently proposed a series of questions that the participants were encouraged to answer. After expressing their opinions, the teacher paraphrased and restated the students' responses. Moreover, in the small group discussion activity, proficient participants were given the responsibility of providing vocabulary hints to other students when they could not retrieve the target words, correcting spelling errors, and supplying advanced vocabulary to achieve clearer

expression. In this communicational environment, the teacher and the proficient participants offered solid scaffolding for less proficient participants. The entire group of participants might, as a result, have been exposed to the beyond-2000 words.

The authentic situations may have played a role in facilitating the elementary school students' learning of more beyond-2000 words. As Agustín Llach and Barreras Gómez (2007) observed, when children use vocabulary in an authentic and meaningful way, they acquire it more easily than when reciting a list of English vocabulary items with their mother language translation. As Hoffman and Ritchie (1997) suggested, the problems in the PBL program should be embedded in relevant, richly contextualized situations such that the learners can acquire knowledge in contexts that closely resemble those in the real world. In this study, the free talk and short conversations may have offered the participants the hands-on manipulation of raw English vocabulary in immediate, authentic contexts. During their oral communication, the participants were likely engaged in identifying new and increasingly complex lexical patterns and acquiring novel concepts of vocabulary usage. They not only practiced how to use the target words, but also incidentally learned additional words.

In sum, these findings suggest that elementary school participants who are instructed with the PBL approach can acquire vocabulary beyond the 2000-word level, master productive knowledge of vocabulary, and are capable of using the words to express their thoughts in a composition activity. On the other hand, students who are not instructed using the PBL approach can acquire vocabulary at the basic-2000 word level, develop receptive knowledge of vocabulary, recognize the target words, and understand the Chinese equivalent of English words.

6. Conclusions

Successful language learning relies on appropriate language usage. This study provides support for a vocabulary pedagogy that helps learners to become proficient vocabulary users by leading them to experience the constructivist learning process. In particular, the problem-based vocabulary learning method is trainable, and elementary school learners can benefit from PBL. In this study, the PBL curriculum was designed to expose learners to a broad range of English vocabulary learning and to prepare them for vocabulary knowledge utilization. The unique characteristics of this curriculum include its primarily interactional nature, the need for skill in assessing problems, and the sub-skills required to produce solutions. The process of identifying a solution to a problem stimulates English learners to actively engage in understanding, remembering, and eventually being able to apply what they have learned. With problem-based learning activities, students have the opportunity to *do* instead of simply wait and see.

The implications of applying PBL to English language teaching are as follows. First, to inspire active interpersonal communication, the learners should be encouraged to talk to each other and practice conversation with the instructor and with their peers; moreover, they need to identify solutions to the problems by themselves and further report their solutions. To complete these tasks, they continuously utter and write sentences to express their thoughts, and also continuously practice and experiment with the usage of the target vocabulary. Second, to form a sustainable learning cycle, the teacher should be able to design and implement problems at an appropriate level of difficulty so that learners can engage with and learn effectively from the materials prepared. The problems used in this study were related to the learners' life experience and the unit topics. Thus, they could continuously utilize the target vocabulary in the context of various situations provoked by the problems. Third, to foster a scaffolding learning environment, the teacher should divide the students into small groups. As shown in self-reports, small group discussion can provide learners with the opportunity to receive immediate feedback, revise their answer to the problem, and gain additional practice outside of class. In sum, the results of the current project can significantly contribute to the field of EFL education, as well as provide valuable knowledge of the effects of the PBL approach on elementary school learners' vocabulary learning and utilization.

Acknowledgments

Appendix A

One-Week Teaching Schedule for Unit 1
    Note that T = teacher, and S = student.
    First period
1. T gives Ss a learning sheet, demonstrating a problem. T uses Chinese to explain the problem and interprets the situations related to the problem. T explains how to complete the table and prepare for presenting the solutions.

※ *Learning Sheet*

PROBLEM: If you were a teacher, what kind of weekly schedule would you like to give your students? Why?

Period	Weekday				
	Monday	Tuesday	Wednesday	Thursday	Friday
1					
2					
3					
4					

2. T displays six target words (math, music, Chinese, art, English, and PE) and explains them in Chinese. T plays the CD, demonstrates the content of the student book on the screen, and leads Ss to complete the practice in the student book.

3. T asks questions to practice these subject names. When presenting each question & answer pair, T first uses Chinese to explain the meanings of the sentences, then asks some students to discuss their answers without any explanations.

※ *The Question & Answer activity*

    Q: How many days are there in a week? (Reviewing the sentences learned in Grade 4)
    A: There are seven days in a week.
    Q: What are the seven days in a week? (Reviewing the words learned in Grade 4)
    A: They are Monday, Tuesday…
    Q: What subjects do you learn in a week?
    A: Math, Music, Chinese, Art, English, and PE. (T asks Ss to list the six subject names.)
    Q: Do you like Chinese?
    A: Yes, I do./No, I don't.
    Q: Which subjects do you like best? (Please say at least two subjects.)
    A: My favorite subjects are _____.
    Q: What classes do you have tomorrow?
    A: I have Chinese, English, and art tomorrow.

4. Ss take part in small-group discussion to assess the learning themes related to the problem and to prepare an oral report. T requires each group to plan an outline for the solution, to review the sentences in the student book, and to use them to write the solutions.

5. Each group submits a draft of the solution in the next period.

Second period

1. T reviews the target words and plays the CD to review the content learned in the first period. T leads Ss to review the problem.

2. T leads Ss to practice the new section of the student book.

3. T has free talk with Ss.

※ *The Question & Answer activity*

    Q: What do you like to play in PE class?
    A: Baseball.
    Q: Why?
    A: It's fun./I can play with my friends.
    Q: Which subjects do you like best? (Please say at least two subjects.)
    A: My favorite subjects are _____.
    Q: What classes do you have today/on Monday?
    A: I have Chinese, English, and art today/on Monday.

4. In the small-group discussion, Ss discuss their solution draft, complete the learning sheet, and prepare an oral report. T requires each group to review the sentences in the student book and workbook. T leads Ss to complete the workbook and provides the answers.

5. Each group submits a draft of the solution in the next period.

Appendix B

The composition of a reply to a pen pal's letter:

Dear friend,

My name is Mary. I live in America. I want to be your pen pal.

I am short and thin. I like green, yellow and red. I love school days and I have many friends in my school. I love art, PE and music. I go to school on foot, but go home by bus. I like to play baseball with my brother in the park on Sundays. I have many questions for you. Can you tell me:

What do you do on Saturday?

What classes do you like?

What time do you go to school?

How do you go home?

I am looking forward to your reply.

<div align="right">

Yours truly,

Mary

</div>

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