The process of implementing problem-based learning in a teacher education programme: an exploratory case study

Chia-Chi Wang

Abstract: Problem-based learning (PBL) is a student-centred instructional approach in which complex real-world problems are used as the vehicle to promote students’ learning of concepts and principles. This paper presents a case study that explored the learning experiences of 18 pre-service teachers and how the instructor was affected when implementing PBL in a course entitled “Principles of Instruction.” Data-collection methods included multiple sources of evidence, such as reflective reports, interviews, participation observations, students’ reports, and a questionnaire. Data analysis consisted of examining, categorising, and recombining quantitative and qualitative evidence to address the initial propositions of the study. This paper demonstrates how pre-service teachers’ professional knowledge, learning engagement, reflective abilities, and teamwork were enhanced through the PBL approach, and that the quality of teaching also improved for the instructor. This study contributes to the professional literature on PBL in teacher-education courses, and may serve to encourage educators to implement PBL in their courses.

Subjects: Education; Teachers; Teacher Education

Keywords: case study; pre-service teachers; problem-based learning; teacher education

ABOUT THE AUTHOR
Chia-Chi Wang is an associate professor in the Center for Teacher Education at the Southern Taiwan University of Science and Technology in Taiwan. Dr. Wang majored in Educational Psychology. Her research interests focus on Creativity, Educational Testing and Assessment in Rasch Measurement and its applications to educational and psychological measurement. She was the secretary General of the first term in the Global Association of Chinese Creativity. Dr. Wang has published more than 20 refereed journal articles and several book chapters in creativity and assessment domains. She has been an anonymous reviewer for many journals, such as Creativity Research Journal, International Journal of Educational Methodology, Research and Practice in Technology Enhanced Learning, Creative Education, Psychological Testing, and Bulletin of Educational Psychology etc.

PUBLIC INTEREST STATEMENT
This study aimed to explore how the problem-based learning (PBL) approach affect the pre-service teachers’ learning experiences and what issues the instructor experienced when adopting PBL resources in her teaching. The findings indicated that pre-service teachers’ professional knowledge, learning engagement, reflective abilities, and teamwork were enhanced through the PBL approach, and that the quality of teaching for the instructor also improved. This study contributes to the professional literature on PBL in teacher education courses and may serve to encourage educators to implement PBL in their courses.
1. Introduction
As global industries change and technology advances, personal success may require the development of different sets of skills than those needed previously. Traditional educational systems may no longer be able to supply companies with graduates with the appropriate mix of skills and experience (Wrigley & Straker, 2015). The practical problems that educators face are complex, varied, and difficult to address, and range across teaching and learning topics, social and community concerns, and classroom environments. Such problems are multifaceted, cross-disciplinary, human-centred, and rarely solved by simple or linear solutions. Thus, it is important and necessary to train students with multiple competencies to cope with the complexities of life in the future. The key factor for the cultivation of talent is related to the quality of teachers. The training of high-quality teachers with effective teaching abilities has always been of great importance. However, teachers of the future should not only be competent at teaching a single subject but also possess multiple competencies to deal with future challenges.

Formal teacher-preparation programs are facing the challenge of ineffective instruction of educational theories (Wang, 2020). In the teacher-training system in Taiwan, pre-service teachers generally think that the content of today’s learning is not relevant to real-world experiences. The gap between learning in class and living in the real world is wide, which causes some pre-service teachers to lose interest in learning. They do not understand the relevance of what they are learning or the value of the knowledge they have learned (Fwu, 2018). Moreover, under the traditional education system, teachers are often transmitters of knowledge. Most students are recipients, waiting for a teacher to issue orders. Teachers have used a narrative method for a long time and the imperative monotonous teaching mode, which cannot produce meaningful learning in today’s contexts. Developing students’ competence in critical and independent thinking through this traditional teaching approach is difficult (Chang-Jiang & Shi, 2018); as such, teacher education has encountered a dilemma, requiring educators in teacher education to modify their teaching strategies.

Problem-based learning (PBL) was originally developed in the mid-1960s as a useful instructional alternative to conventional teaching in medical education (Loyens et al., 2008). PBL is a student-centred instructional approach that is applied at many educational institutions. The PBL process does not focus on solving problems with definite solutions; instead, it allows for the development of other desirable skills and attributes, including knowledge acquisition, enhanced team collaboration, and communication. In PBL, students learn by solving problems and reflecting on their experiences (Barrows & Tamblyn, 1980). As such, PBL is well suited to helping students become active learners, because it situates learning in the realm of real-world problems and makes students responsible for their learning. In PBL, students work in small collaborative groups and learn what they need to know to solve a problem. The teacher acts as a facilitator to guide the students in developing the cognitive skills required for problem solving and collaboration (Hmelo-Silver, 2004).

Many studies have confirmed that PBL improves the performance of students, not only in medical education but also in science, engineering, social sciences, business studies, and teacher education (Walker & Leary, 2009). For example, studies on topics related to problem solving (Helmi et al., 2016), questioning strategies (He et al., 2018), creativity (Gallagher, 2015; Zhou & Shi, 2015), social skills (e.g., collaborative learning and communication skills) (W. J. Chang & Yeh, 2009; Zhou & Shi, 2015), information literacy and motivation for learning (N. C. Chang & Hsu, 2016), science study (Gunter & Alpat, 2017), and the teaching of professional knowledge and skills for pre-service teachers (Chen, 2008; Chen & Wang, 2005; Edward & Hammer, 2006; Erdogan & Senemoglu, 2017; Golightly & Raath, 2015; Hsu, 2013; Hsu & Lin, 2016; D. R. Chang & Lin, 2016) have confirmed that PBL is an effective learning strategy. The above literature on teacher education indicates that PBL helps students to construct their professional knowledge in the field of education by promoting dialectic and connection between educational theory and practice, establishing professional cooperative communities, and enhancing students’ ability to criticise and reflect on themselves.
However, there is little research regarding how the PBL approach affects educators’ teaching performance or pre-service teachers’ learning experiences in the context of higher education academic development.

The Principles of Instruction course is the main subject/course in the pre-service teacher-training curriculum in Taiwan. As educators, we should strive to design and develop instruction that is effective, consistent, and meaningful. The purpose of this course is to train pre-service teachers with basic instructional abilities, including providing an understanding of the basic concepts of instruction, the theoretical basis of teaching, teaching methods in the cognitive field, teaching methods in the field of affective skills and skills generally, individualised teaching methods and principles, and teaching evaluation assessments. As an instructor and researcher, I taught this course in a centre for teacher education twice from 2016 to 2017; the main teaching method used in the classroom at that time was direct instruction. Based on previous teaching experience, I found that some pre-service teachers had problems in studying. For example, the motivation for one-quarter to one-fifth of pre-service teachers in the classroom was rather low and the learning experience for them tended to be inactive. The pre-service teachers’ general ability to state their views systematically on educational issues, specifically, their critical reflection, communication skills, and problem-solving capabilities, needed to be strengthened. In an attempt to provide a context for delivering classes that address the multiple abilities that pre-service teachers must have, I proposed implementing the PBL educational model in the Principles of Instruction course.

For the purpose of this study, a PBL environment is one that encourages and enables participants to accept appropriate new knowledge using their current knowledge and skills. Based on this, this study uses the basic subjects of the pre-service teacher training course, the Principles of Instruction, as the research field and integrates the curriculum content into the PBL model. Yin (2014, p. 10) thought that the exploratory case study is a research approach used to initially explore a contemporary phenomenon that is inseparable from the context in which it exists. Therefore, this paper reports on an exploratory study that considered the following research questions: How does the PBL approach affect students’ learning experiences? What issues are experienced by the instructor when adopting PBL resources in his/her teaching?

2. Methodology

2.1. Research design
The case study using embedded mixed method (EMM) research design was conducted across one semester (September 2018 to January 2019). In an embedded mixed methods case study, the researcher collects and analyses both quantitative and qualitative data to examine a case (Creswell & Clark, 2010). Case studies allow examination of a phenomenon from different angles “in its natural setting”, by triangulating the research and thereby ensuring the validity of findings (Yin, 2014). In the context of this research, I was an insider-researcher. Insider-researchers may be confronted with role duality, as they often struggle to balance their insider and researcher roles (DeLys, 2001; Gerrish, 1997; Unluer, 2012). As an instructor/researcher, my case study research explored the learning experiences of pre-service teachers on implementing PBL in the Principles of Instruction course. I am a full-time assistant professor (a female with 3 years of experience) at a centre for teacher education in southern Taiwan. I was involved in teaching and assessing pre-service teachers’ work, which may have affected how pre-service teachers chose to respond. However, this familiarity may also have prompted participants to feel more comfortable in responding. To reduce bias and ensure credible insider research, my findings and statements are supported by feedback from an external researcher in the field of qualitative research.

2.2. The context of the study
The goal of the Principles of Instruction course is to provide a systematic introduction to the methods and techniques to be used in class, with a focus on developing the basic abilities required of teachers
at all levels of education. In terms of curriculum and teaching, the PBL curriculum, instructional design, and procedure can be modified based on different learning goals and situations (Barrows, 1986). I employed the PBL process designed by N. C. Chang and Hsu (2016), which includes five steps: demonstrate, analyse, explore, solve, and evaluate the problem. This process was implemented in multiple evaluations of the PBL process in the Principles of Instruction course (Figure 1).

The course format was a class meeting, one day per week, for 100 minutes. In this course, the entire semester was delivered as a group discussion, supplemented by my input as the instructor. In total, 12 topics were covered over a period of 12 weeks. Before the course, two experts whose major was curriculum design and instruction, were invited to examine the validity of the content of the lesson plans. Table 1 shows an example of a lesson topic.

In addition, I changed the presentation style of the final report and requested that the four groups of pre-service teachers present their work (four kinds of teaching instruction) in a PBL style, including situational exercises (demonstrate the problem); group discussions (analyse, explore, and solve the problem); and oral reports (evaluate the problem). The situational exercises involved the group virtualising a situation and carrying out a drill based on the theme. Using group discussions, the group members discussed issues related to the situation by presenting the problem and leading the whole class in analysing/discussing and summarising the problem and developing/organising the appropriate teaching approach. In this way, the teaching content developed gradually as a group effort. Oral reports entailed group members introducing the definitions, connotations, type, and advantages/disadvantages of the teaching method. Finally, I integrated and summarised the main content with respect to the teaching instructions.

### 2.3. Participants

The case study included 18 pre-service teachers (5 men, 13 women) who selected the course at the university in Taiwan. Among these pre-service teachers, there were 3 (16.70%) from the College of Business, 13 (72.20%) from the College of Humanities and Social Sciences, and 2 (11.10%) from the College of Digital Design. Four students were sophomores, two were juniors, three were seniors, one delayed graduation, and eight were master's students. Their ages ranged from 19 to 46 years (mean age, \( M = 27.11 \) years; standard deviation, \( SD = 8.57 \) years).

In the interests of research ethics, I told all participants the content of the course and the evaluation method in the syllabus. To protect their rights and interests, they were asked to fill in the research informed-consent form voluntarily and also to freely decide whether to agree to include the previously collected data in the final research analysis.
Table 1. The teaching example of implementing PBL in the course

| The procedure of PBL          | Topic: class management/teaching design                                                                 |
|-------------------------------|----------------------------------------------------------------------------------------------------------------|
| Demonstrate problem           | Students were introduced to an ill-structured problem that was related to their lives to increase their interest and motivation. For example, there was a situation: In your class, there are two students who love to change their seat, sit together and chat with each other. The teacher requests them not to do this, but they don't care about the teacher. As a teacher, what will you do? |
| Analyse problem               | Students analysed the problem to determine what they know about it and independently investigate what information was required to address the problem. |
| Explore problem               | Students analysed the problem and collaboratively identified necessary actions. For example, the instructor might present several discussion questions and guide students to explore problems. Such as: why do students behave poorly in class? How do other students respond to poor behaviour in class? If the teacher tries to correct students' behaviour, how will they feel and so forth? Then, students started a group discussion and implemented an action plan. |
| Solve problem                 | Students generated possible solutions to the problem. They had to structure their knowledge and come to conclusions through group discussion. |
| Evaluate problem              | Students considered the consequences of each solution, selected the most viable solution through metacognition and shared their results with other classmates. |
| Multiple evaluations          | Students' performance was assessed by self-evaluation, peer-review and teacher-evaluation. |

2.4. Data collection

Multiple data sources were collected, including reflective reports, participant observations, semi-structured interviews, students’ reports, and questionnaires.

2.4.1. Reflective reports and participant observation

I wrote reflective reports that described the teaching process for each class, classroom observations, and students’ thoughts and responses to the PBL exercise. In addition, a self-evaluation checklist (Hsu, 2013) for each individual pre-service teacher was completed to evaluate teaching performance based on the PBL model. The checklist was a 10-item self-report instrument that included five categories: excellent, good, not bad, needs improvement, and bad. Necessary adjustments were made in a timely manner, as a better understanding of the pre-service teacher’s development was attained, as further reflected in the PBL performance evaluations in theory and in practice.

2.4.2. Semi-structured interviews

At the end of the semester, semi-structured interviews were conducted with pre-service teachers. To explore a contemporary phenomenon that is inseparable from the context in which it exists (Yin, 2014), all of the interviews began by posing open-ended questions of the “what,” “how,” and “why” types, such as “What were the most significant experiences you had during the course?”, “How did the teaching approach change your beliefs, abilities, and enthusiasm after studying?”, and “What are your perceptions of PBL?”
2.4.3. Students' reports
Students' reports were mainly concerned with the student learning outcome, including the classroom records of the group-case problem analysis and operation, the design and description of the teaching-observation plan, the PBL group report, and their personal reflection report. Hence, the pre-service teachers' classroom participation, classroom assignments, group reports, and final report were used to assess their learning through PBL.

2.4.4. Questionnaire
The Learning Engagement Scale for College Students (LESCS) compiled by Lin and Huang (2012) was used in this study to measure the students' engagement in the pre-service training course. LESC is a Likert-style, five-point scale, with 1 to 5 points assigned for ‘completely inconsistent’, “mostly inconsistent”, “partially consistent”, “mostly consistent”, and “completely consistent”, respectively. LESC consists of five subscales: “Skills”, “Emotions”, “Performance”, “Attitudes”, and “Interactions”, for a total of 20 questions. The LESC was used to measure the average scores of five subtests and that of the total quiz grade. Cronbach's alpha coefficient of the total scale was .86, and Cronbach’s alpha coefficient of the five subscales ranged between .71 and .79, indicating that the LESC has good internal consistency for this study.

2.5. Data analysis
Thick descriptions (Maxwell, 1992; Stenbacka, 2001) of the interviews and classroom observation data were completed to represent the actual conditions in a detailed and complete manner. These descriptions included the participants’ personal backgrounds, teaching processes of PBL, and their tone and emotion during interviews. The participants were actively represented in the analyses by clear, detailed descriptions. The credibility of the data was thus confirmed via feedback from the participants. My reflection was coded based on reflective reports (Rr) category and date. For example, Rr_20181129 refers to the date, 29 November 2018, of the reflection. A tripartite code was assigned to each set of research data obtained from the students; for example, SI_A3 refers to the semi-structured interviews researched by Student #3 in Group A; SR_A4_w11 refers to the student report researched by Student #4 in Group A at Week 11.

To increase research validity, triangulation was performed using multiple data sources (Yin, 2014), such as verbatim manuscripts and tables of recorded classroom observations and student reports, as well as methods involving interviews, observations, and an expert panel. An external expert in qualitative research also served on the panel to ensure that there was no research bias. Quantitative analysis focused on differences in students' learning engagement pre- and post-test via a dependent-sample Wilcoxon signed-rank test. The analytical results were presented in terms of both written descriptions of the qualitative results and quantitative numerical descriptions (Miles & Huberman, 1994).

3. Results and discussion
This study aimed to explore how the PBL approach affects students' learning experiences and the issues that I experienced when adopting PBL resources in my teaching.

3.1. Changes in student learning experiences in the PBL class
According to the responses of LESC, the average pre-test score for learning engagement was 72.72 (SD = 8.97), and the average post-test score was 74.94 (SD = 9.95); this reflects a non-significant difference (Z = −1.542, p = .123) between the pre-and post-tests for learning engagement. The differences between pre- and post-test scores for all sub-dimensions were non-significant, except in the case of the dimension of interactions (Z = −3.213, p < .05) (Table 2). This implies that PBL may improve interactions among group members in the learning process.

In the PBL course, in addition to circulating through the class when the pre-service teachers were in discussion, I was also available to answer questions on the topic at hand. I observed that the pre-service
teachers with teaching experience expressed their opinions more fully; the others expressed their opinions more frequently but not in detail. This is an example of students learning by solving problems using PBL and reflecting on their experiences (Barrows & Tamblyn, 1980). This above finding echoes the results reported by D. R. Chang and Lin (2016), W. J. Chang and Yeh (2009), and Zhou and Shi (2015). An excerpt from one of the reflective reports on this is given below:

In today’s class, I observed that some students who usually speak less often readily shared their perspective and put forward their arguments . . . . I found that certain students with teaching experience (such as Group A) focused more easily on the problems during the discussion and were better able to classify the discussion content and present the group consensus systematically. However, other groups only discussed a few elements of the film that I showed and did not link the elements together systematically. (Rr_20181001)

In addition, when I led pre-service teachers to reflect on their lack of guidance skills in class, it may have improved their metacognitive abilities through a better focus on this aspect.

When student A was a facilitator in the presentation, he only listened to the other members of the group’s conclusions without giving any feedback. I thought that it would be good to get some feedback from the students before they presented their oral report. I asked the entire class to share their feelings with me and asked them how they felt during the discussion? Some students felt that the problem should be defined more clearly and that the leader should give better guidance, such as feedback . . . etc. Through such teaching activities, I observed that students were better able to understand the presented discussion method. The essence of teaching is not just in listening to class participants and learning to navigate classes, but being able to really understand the spirit of teaching through the process of implementation, discussion, and sharing. (Rr_20181210)

Several studies have revealed that PBL is effective in fostering students’ knowledge, comprehension, application-level achievements, deep learning, and an understanding of how theory relates to practice (Edward & Hammer, 2006; Erdogan & Senemoglu, 2017; Golightly & Raath, 2015). In the 11th week, an elementary school teacher with an anthropology background was invited to share information about mobile-device applications in teaching. Based on this theme, pre-service teachers reflected on the fact that teachers at educational sites use the technology, but were not controlled by the technology. Some pre-service teachers reflected on their original knowledge and corrected their earlier perceptions. One pre-service teacher said:

The purpose of technology is not to help those students who are already excellent to become more excellent, but to shape the subjectivity of students. The continuous advancement of science and technology will inevitably increase students’ dependence on
groups and communities. However, it is because of this that they require teaching and learning. (SR_D1_w11)

The PBL process is focused on students’ reflections and reasoning to construct their own learning (Dolmans et al., 2016; Gunter & Alpat, 2017). PBL has benefits for learning outcomes and the development of reasoning and critical thinking skills; by solving authentic problems, students are better able to connect theory to practice (Blackburn, 2017). I observed that the higher the students’ learning engagement and problem-solving performance, the higher their professional knowledge in the course (Rr_20181224). Additionally, this study demonstrated that the PBL approach enhances pre-service teachers’ positive learning attitudes, team cooperation, and learning engagement. Two pre-service teachers expressed the following:

In each class, the teacher’s explanation and mutual excitement between classmates expanded my imagination and ability to think creatively. This class makes me consider my teaching more thoroughly. Although I often talk about many things that are unrelated to the course, I find that I actually get a lot from this type of mutual back and forth. I like this highly interactive way of learning and feel more in tune with my team members. (SI_A2)

I am grateful to the teacher for planning a course that focuses on learning by doing, which, in my opinion, is more enjoyable! I really like the way the teacher encourages imagination and thoughtful reflection through discussion. After the explanation and integration, we gain a basic understanding of the theory behind the teaching principles. The teacher also facilitated many workshops and provided us with great learning opportunities. These experiences are very practical and allowed me to learn about the importance of combining theory and practice. (SI_D1)

3.2. Reflective reports of implementing PBL
In the curriculum design and teaching process, the factors considered included curriculum goal setting, curriculum and assessment design, learner-characteristics analysis, teacher–student interactions, and so forth. Therefore, I proposed reflection regarding the arrangement of the teaching programme and the discussion atmosphere as follows.

3.2.1. Teaching programme arrangement
In terms of the curriculum and teaching implementation, the PBL teaching process is not static and has the advantage of combining curriculum requirements with flexible combinations of teaching resources. Instructors can evaluate the teaching ability, familiarity with PBL, curriculum design, and teaching time and resources, as well as adjust the teaching mode of PBL to achieve different educational goals (Barrows, 1986; Yang & Chang-Lai, 2005). Overall, more than 94% of the pre-service teachers evaluated my teaching performance as good; the external researcher and I both evaluated the PBL process of the course as “good” using a self-evaluation checklist.

Ertmer and Simons (2006) identified several challenges for many instructors when implementing PBL. For example, instructors need support and guidance in adapting to their new role of facilitating student inquiry, providing constructive feedback, and applying new classroom-management strategies (Blackburn, 2017). In this study, I faced similar challenges, especially with regard to the proper combination of teaching time and course content (Rr_20181008). For future instructors who would like to use PBL in the classroom, I recommend that they initially use a small case or situation as an example exercise. This would facilitate follow-up discussions in groups. In addition, I realised that in some cases, I had designed problems for some lesson topics that were too superficial, preventing an in-depth discussion of the outcomes by the pre-service teachers (Rr_20181029).
In view of this, I adjusted the teaching content and provided students with directions to discuss the problem in more detail. Indeed, it helped them to focus on the core of the problem, as stated in one reflective report:

During today’s discussion, I tried to provide different levels of discussion from different perspectives, including motivation, reaction, interaction, and future actions. I found that students were more focused during the discussion, and the discussion was deeper. In my point of view, someone who would like to implement PBL in his/her classroom could provide more situations, design different levels of questions, and let students analyse the discussion in the future. Perhaps in the group report, let the students attempt to design the problem and lead the entire class in a discussion (Rr_20181112).

For this study, I requested that the pre-service teachers present their final reports in a PBL mode. When they presented their final reports, I observed that other pre-service teachers were more willing to ask questions and make their own points. This demonstrates the power of PBL instruction, in which the instructor effectively acts as a facilitator to guide the students to develop the cognitive skills required for problem solving and collaboration (Hmelo-Silver, 2004).

3.2.2. Discussion atmosphere
Initially, pre-service teachers seemed to feel awkward when starting their first discussion. An ice-breaking activity was implemented to enable group members to become more active in the subsequent discussion. Such an ice-breaking activity was necessary to allow the group members to become more familiar with other members of the group and, therefore, more comfortable in presenting their individual views/perspectives. Furthermore, I also suggested the following:

In group discussions, there must be a host and a reporter of the main group discussion, who can support the atmosphere of the discussion in being more active and efficient. It may be possible to change the main discussant and observe the difference in every discussion (Rr_20181001).

In general, pre-service teachers engaged in the discussion process and seemed to have a positive attitude toward this PBL approach. Based on discussion and feedback from group members, they thought that this teaching process better incorporated different individuals’ views for solving
problems and reflecting on their experiences, leading to them forming their own more deep-seated views. One pre-service teacher stated:

I like to discuss things with my team members, find the best way to discuss new topics among team members, understand other people’s ideas, and be part of a cooperative group effort. Every time the group offers opinions and suggestions, I feel good because the outcome covers numerous perspectives. Others see things that were not obvious initially. This is why I think this course is quite different from other courses that use direct teaching instruction. (S1_B3).

3.3. Main contribution of this study to implementing PBL
In summary, integration of PBL into teacher-training courses can help instructors to enhance pre-service teachers’ professional knowledge in the following ways: by constructing professional knowledge in education, promoting dialectic and connection between educational theory and practice, establishing professional cooperative communities, enhancing critical and reflective abilities, and fostering positive learning attitudes. The implementation of engaging and effective PBL components is not easy. My experience has shown that with the right teaching beliefs and an understanding of the students, many implementation challenges can be overcome.

Based on the evidence of this study, I constructed a cycle diagram of PBL in teaching and learning with an external researcher, shown in Figure 2. Implementing PBL in the classroom has really improved my abilities in the following aspects:

(1) Curriculum design, teaching and evaluation: involves planning activities, readings, lessons, and assessments that achieve educational goals.
(2) Class management: involves the variety of skills and techniques that I use to keep students focused, attentive, organized, orderly, on task, and academically productive in class.
(3) Reflection: involves dedicating time to evaluate my own teaching practice, examine curricular choices, consider students’ feedback, and to improve their learning.

These abilities will be fed back to pre-service teachers through the teaching process, thereby improving their performance in the following aspects:

(1) Professional knowledge: refers to their professional knowledge of practice and how that might influence their actual teaching and professional development.
(2) Learning engagement: refers to the degree of attention, interest, and passion that pre-service teachers show when they are learning or being taught, which extends to the level of motivation they have to learn and progress in class.
(3) Reflective abilities: refers to reflective practice to connect pre-service teachers’ personal backgrounds with their placement experience concerning their teaching topics.
(4) Team cooperation ability: refers to the positive impact of cooperative learning on pre-service teachers’ professional development.

Thus, in this cyclic process, teaching PBL is learning for me, as the instructor, and learning by teaching for the pre-service teachers.

4. Conclusions
In this study, a PBL classroom was more engaging than a traditional classroom. The findings indicate that pre-service teachers’ professional knowledge, learning engagement, reflective abilities, and teamwork were enhanced through the use of a PBL teaching approach and practical application of PBL. Pre-service teachers also developed a deeper understanding of the Principles of Instruction course through PBL, and how to apply PBL in their teaching methods. Furthermore, the
quality of the teaching improved. The ability to create a positive atmosphere for discussion and use multiple evaluation formats was enhanced by the PBL approach.

The findings also indicate that teachers’ teaching beliefs and perceptions of students are key components in implementing PBL. However, the purpose of this research was only an initial exploration of how PBL affects students’ learning and teachers’ teaching, and it did not further analyse teachers’ questioning or guidance skills. Future PBL research could explore how teachers integrate different levels of questioning, multiple evaluations and specific feedback in the classroom, and focus more on research into teacher-student interactions to improve the quality of teaching and learning. In addition, group discussion is an important process in PBL. Future research could also record the process of group discussion in detail, and explore the changes in the cognitive development ability of students at each stage in a higher-education setting. Finally, this study contributes to the professional literature on PBL in teacher education and may serve to encourage educators in higher education to implement PBL in their courses.

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Author details
Chia-Chi Wang
E-mail: wcw0805@gmail.com
ORCID ID: http://orcid.org/0000-0002-1263-4890

1 Center for Teacher Education, Southern Taiwan University of Science and Technology, Tainan City, Taiwan.

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