

## *Exploring Learning Effects of Using Different Scaffoldings on Problem-Based Learning*

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### **Abstract**

The essence of problem-based learning is to construct knowledge, to share knowledge, to approach their goal, and to solve the problems. However, in online collaborative construction environments, environmental changes and personal characteristics will considerably affect the effectiveness of the problem-based learning. Therefore, online instructors need to provide facilitations to help learners completed their learning tasks. In this study, our aim is to develop several strategies that employing scaffolding theory to facilitate online problem-based learning, three types of scaffoldings are to be included: meta-cognitive scaffolding, procedural scaffolding, and blended scaffolding that integrates the first two. The effects of various scaffolding schemes will be explored in terms of learning performance. Google Site platform will be used to create the online constructive environment. The subject-matter for the problem solving instruction is electricity generation. The research subjects will be fifth graders from a selected elementary school. They will be divided into three groups: procedural scaffolding group, meta-cognitive scaffolding group, and blended scaffolding group. Each group will be guided by different strategy, and they will learn related knowledge from problem solving. We will evaluate their learning outcomes of three groups to analyze the differences of the three groups.

Keywords: problem-based learning, meta-cognitive scaffolding, procedural scaffolding

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## **Introduction**

Problem-based learning (PBL) is defined as learner-centered learning. Learners discuss the issues through open-ended questions, and then build team knowledge as appropriate. Online learning overcomes space constraints, allowing rapid exchange of information, and effective team building. environments, environmental changes, and personal characteristics will affect the construction results (Zheng & Zhuang, 2008).

Learners' self-construction of their learning content may be difficult. Students need to adapt to a new environment and learn new technology and new information to do so (Johnson & Johnson, 1996). In addition, individual differences also cause unequal participation of students. In cyberspace, student's learning processes are more self-directed with compared to traditional classrooms learning. Such self-directed learning processes need to be guided, assisted, and monitored by online instructors. (Lee, 2010). Previous studies indicate that incorporating scaffolding instructional strategies with online collaborative learning results in better learning outcomes. In recent years, scaffolding strategies have widely been used in the network software tools, courses, and other resources to help students to achieve successful learning. Although the teacher plays a important role in the instructional process, the student is also an active participant so that scaffold interactions are a function of participation by the teacher and the learner. (Puntambekar & Hubscher, 2005).

Currently, metacognitive scaffolding was commonly used in construction learning programs. Metacognitive scaffolding can help learners recall prior knowledge, so that learners take the initiative to recall the knowledge learned in the past and take the initiative to find relevant information. On the other hand, procedural scaffolding uses web site maps, operating procedure instructions or navigation maps, etc., to clarify learning steps to reduce cognitive load and elucidate the learning objectives.

Sharma and Hannafin (2007) suggested that a complete learning activity is most likely to be achieved if there are a balance and fusion between the metacognitive scaffolding and the procedural scaffolding. Therefore, in this study, we attempt to propose a blended scaffolding strategy, combining the cognitive hints provided from the metacognitive scaffolding and the operational guidance provided by procedural scaffolding.

This study will discuss the impact of different types of scaffolding in online problem-based learning courses, we attempt to propose an improved scaffolding strategy, combined with the meta-cognitive scaffolding and procedural scaffolding's characteristics. Through this study, we will set up the cognitive scaffolding, the procedural scaffolding and the blended-scaffolding into the problem-based learning course and explore the different level effect brought by different scaffolding strategies. In addition, we also concern to students whether they have different influences on the satisfaction of the course and learning process after the course.

## **Literature Review**

### **Scaffolding in the Online Environment**

Scaffolding theory is widely used as a teaching strategy. It is originated from Vygotsky's (1978) sociocultural theory of cognitive development, emphasizing adults and experts as sources of children's social experience and knowledge. Wood, Bruner, and Ross (1976) defined scaffolding as adults or experts providing appropriate assistance in the learning process and helping learners to achieve learning goals until they are able to complete the task independently. Scaffolding is adjustable and flexible, and it can help students with different learning skills, backgrounds, and learning styles (Ling & Harun, 2014). When adults or experts construct the scaffolding, they must have a common understanding of learning objectives with learners, monitor and assess learners at any time in terms of progress and status, revise the contents of the scaffold as appropriate, and give support and feedback (Azevedo, Cromley, Winters, Moos & Greene, 2005).

Quintana et al. (2004) found that the environment of network communication technology flourished with provision of appropriate scaffolding that can reduce the cognitive load of students and help students manage their learning tasks. Use the scaffolding in online environment is also helpful to logical thinking and the correct use of the strategy. Sun, Wang, and Chan (2011) also mentioned that digital scaffolding can enhance learning motivation.

Past studies have well categorized scaffoldings. Hill and Hannafin (2001) argue that mentors need to provide different types of scaffoldings in different learning situations. They specified four categories of scaffoldings: conceptual, procedural, metacognitive and strategic. In this study, we will employ procedural scaffolding and metacognitive scaffolding as they seem to be more appropriate for online environment.

Procedural scaffolding helps learners understand how to use learning resources so that they can understand their learning needs. It also can reduce students' cognitive load, so they can focus more on the main learning tasks, it is usually presented as simple text guidance for the site map, and such learning maps are able to guide students learning resources (Hill & Hannafin, 2001). Procedural scaffolding allows learners to adapt to unfamiliar learning environments, reduce cognitive load, and focus more on learning activities (Molenaar & Slegers, 2014).

Metacognitive scaffolding can help students assess their prior knowledge and learning deficiencies; it is presented like simple hints or questions about the learning objectives and content, and it helps students organize their knowledge (Hill & Hannafin, 2001). Reiser (2004) states that the knowledge problematizing and addition the course can help students to make basic inferences about concepts and to think about whether their ideas are correct.

In line with the above discussion, we understand the advantages of the scaffolding application in the network environment, and we will try to use metacognitive scaffolding and procedural scaffolding simultaneously in the PBL courses in the present study. Sharma and Hannafin (2007) also pointed out that procedural scaffolding and meta-cognitive scaffolding can make the learning content focus on the

learning topic. However, there is a need to strike a balance between learning activities to improve the degree of completion.

### **Employing scaffolding strategies in problem-based learning**

PBL is defined by Barrow and Tamblyn (1980) as the process of question-realizing and problem-solving, which allows learners to control the path of learning. As such, PBL is closely related to our daily life. PBL is an approach to learning where curricula are designed with problem scenarios central to student learning in each curricular component (Savin-Baden & Wilkie, 2006). The purpose of using PBL includes learning knowledge building, enhancing problem-solving skill, and promoting self-directing and learning motivation (Barrows, 1986).

In recently years, PBL is not just used with face-to-face teaching—it is also applied to the online environment. Savin-Baden and Wilkie (2006) asserted that PBL in an online environment is not an approach to replace the traditional form of learning, but is about complementing and developing what is already in existence. In online PBL, students use web-based tools to share information and construct knowledge.

Fund (2002) examined the effect of scaffolding in a computerized environment for students solving problems about science in a simulation of laboratory experiments. With this study finding showed that scaffolding provides a structured component of the course and provides a framework for problem solving. The scaffold has a powerful influence on learning outcomes. On the other hand, Hmelo-Silver, Duncan and Chinn (2007) pointed out the PBL is a powerful and effective model of learning. When an instructor applies the scaffolding in PBL, it can reduce the cognitive load and help students to learn in complex domains.

PBL is a learning mode that focuses on discussion, sharing, and problem solving. Scaffolding can be used as a guide in the discussion process, helping to enhance the learner's discussion and improve the interaction between the groups.

### **Objectives of the Study**

In this study, we will use different scaffolding strategies in PBL online course, including meta-cognitive scaffolding and procedural scaffolding, and a blended scaffolding that combines the two characteristics. This study intends to answer the following questions:

1. In the online problem-based learning, which scaffolding type is more effective to guide students' learning?
2. When we provide different scaffolding supports in the same course, does blended-scaffolding or single-scaffolding yield better learning outcomes?

## Research Methodology

### Methods

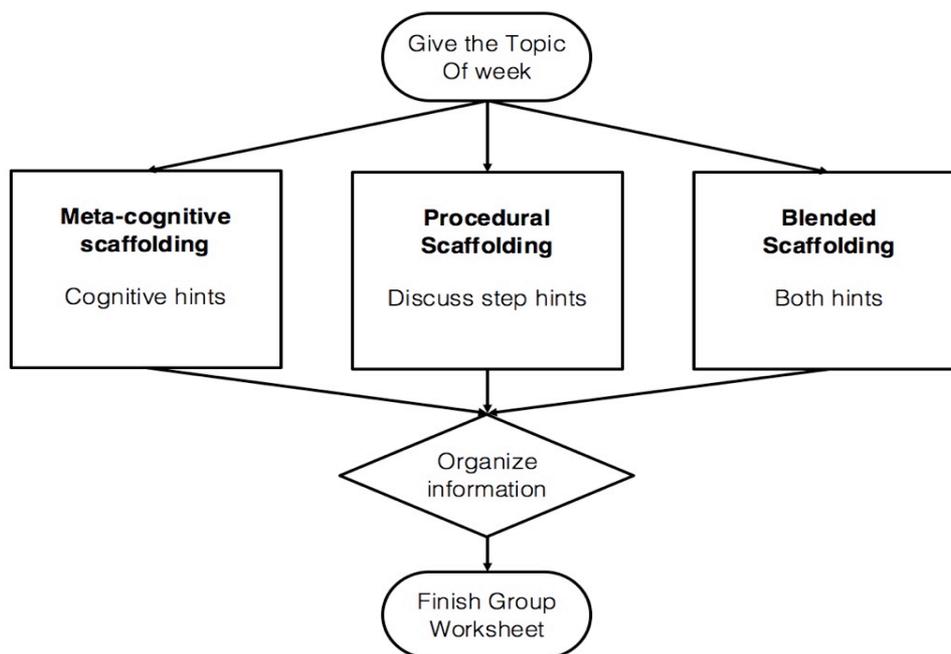
This experiment will be created using Google-Site, a web-based collaboration platform. The subject of the course is “Electricity in Taiwan.” In this course, a student-led learning process, the mentor will give assistance. At the beginning of the course, it will be explained in the classroom to the student. They will need to share information, discuss problems, and construct knowledge on the platform. In addition, the learning content of each group is the same; the difference is that they will receive different additional assistance.

### Participants

The experiment subjects fifth graders from a selected elementary school who enrolled for the science course. They will be divided into 9 groups for three categories: 3 meta-cognitive groups, 3 procedural groups and 3 blended groups.

### Procedure

This experiment will execute for 3 weeks. Before the course beginning, instructor will introduce about the meaning of PBL, and how to use the platform. Learning activities process shown as Figure1.



**Figure 1.** Learning activities process

At the beginning of the course, the learner will be informed about the subject. Every group then begins to discuss with the members to search and figure out for relevant information they found. The scaffolding will be mainly built in this step. The details of the different scaffolding types are described below:

### (1) Metacognitive Scaffolding: Cognitive hints

Cognitive hints assist learners to recall the past experience and think about how to solve a problem. Examples are as follow:

1. I have seen on television many nuclear-related news items; have you seen any of these? You can share with the members any information you have from such sources.
2. Nuclear power generation does not seem to be an excellent power generation option. Maybe you can start looking for some information about nuclear power generation with your teammates and share it with us.

We want use life-related issues to attract the attention of students; problematizing meta-cognitive scaffolding can lead students to think, and promote group cooperation and discussion (Molenaar & Slegers, 2014).

### (2) Procedural Scaffolding: Discuss step hints

Procedural scaffolding focus on the steps to complete the learning task, giving hints as to what the learner needs to finish next. The following are examples:

1. Now use “nuclear power” as a keyword, and collect information with your teammates.
2. From the information you found, please explain what nuclear power generation is, as well as its advantages and disadvantages.

Through such guidance, students can immediately know what needs to be done, improving the likelihood of achieving the goal. Through the systematic process of understanding the complexity of learning content, the students can more clearly form their own learning tasks (Puntambekar & Hubscher, 2005).

### (3) Blended Scaffolding: Metacognitive and procedural

This group will be prompted by a mixture of the other two groups (i.e., given the contextual content and given the specified steps to complete the course). The following is an example:

1. Have you seen news about nuclear energy on TV? Perhaps you can tell me about nuclear power generation, and its characteristics, review the relevant information together with your teammates, and then share it with us.

Combined with the advantages of the other two kinds of scaffolding, blended scaffolding can lead students to think at the same time, but also to complete the expected learning goals.

After they finish the information searching, and organize their information, they will receive the group worksheets. The worksheet is a quiz about the discussion topic, we

will use it to evaluate their learning outcomes and use the score to analyze differences between groups.

### **Expected Results**

In this research, we wanted to find out:

1. How to use scaffolding strategy in online PBL
2. What kind of scaffolding strategy can lead students to discuss efficiently and promote learning achievement.

We seek to use different scaffolding strategies for the PBL curriculum of the same topic, including a combination of metacognitive scaffolding and procedural scaffolding. It is expected that such blended scaffolding can redress the deficiencies of the other two single scaffolding types. The study is also expected to provide a new teaching strategy for online PBL to help students. Although this research has not yet been finished, we are continuing to develop it in expectation of its completion.

The results of the study could yield suggestions to instructional designers. Additionally, we suggest researching other types of scaffolding. Scaffolding has many various forms and application; as a future study, instruction designers can focus on how to improve interactivity and enhance learner's learning motivation.

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