A COLLABORATIVE BLENDED LEARNING APPROACH FOR LEARNING WEB PROGRAMMING

Wing Shui Ng and Gary Cheng
The Education University of Hong Kong
Hong Kong

Abstract

The learning of programming has been considered to be very difficult. To assist a class of 25 undergraduates to learn web programming, the researchers applied a collaborative blended learning approach in this study. After obtaining knowledge from lectures, the students were required to develop questions for generating an online quiz for the whole class. Results indicate that a high proportion of the questions were of high quality, and these reflected students' positive attitude. The students also demonstrated good performance in the online quiz, and it provided evidence of the effectiveness of the pedagogy. This study suggests that a collaborative blended learning approach could be applied to support students to learn web programming.

Introduction

With the development of technology, a webpage is no longer solely for displaying information in a static manner. Instead, many webpages nowadays have been designed in a dynamic way with multiple functions. The design of dynamic webpages involves sophisticated skills of web programming with the use of languages such as Extensible Hypertext Markup Language (XTHML), Cascading Style Sheets (CSS), JavaScript and Extensible Markup Language (XML). However, learning programming skills and concepts has been considered to be very difficult since it involves complex cognitive processing. Moreover, the linguistic intricacies of computer programming languages also make it difficult to learn.

In order to assist a class of undergraduates to learn web programming, the researchers applied a collaborative blended learning approach in this study. The use of a blended learning approach in designing courses, particularly in higher education, has been increasing (Mozelius & Hettiarachchi, 2017). Blended learning is generally referred to the pedagogy that combines face-to-face classroom teaching with an online learning component (Sharma, 2017). The teaching strategy in this study involved a blended learning component and a collaborative online learning component. In the following sections, the difficulties of leaning programming, the advantages of a blended learning approach and the underlying rationales of collaborative learning are discussed. It is followed by an elaboration of the method and results. A discussion and conclusions are provided at the end of this paper.

Literature Review

In this section, the researchers highlight the difficulties of learning computer programming. The rationales of the blended learning approach are then discussed. The importance of a collaborative approach to enhance learning is also explored.

Difficulties with Computer Programming

Programming can be regarded as a very useful skill. Particularly, it has been highlighted in recent developments of science, technology, engineering and mathematics (STEM) education due to its possibilities to develop the digital economy. The education bureaus of many countries, such as United States, England and Singapore, have initiated policies to promote the learning of computer programming (Department for Education 2014; Ministry of Education, 2017; Smith, 2016). The importance of computer programming is considered comparable with reading, writing and arithmetic. However, programming, such as using web programming languages in the creation of dynamic webpages, is a complex intellectual activity, and few students find it easy to learn. Although it is common to include programming courses in higher education, these courses are generally regarded as difficult and often have high dropout rates (Ahoniemi, Lahtinen, & Erkkola, 2007).

A major difficulty involves the linguistic intricacies of computer programming languages (Gomes & Mendes, 2007; Hristova, Misra, Rutter, & Mercuri, 2003; Jenkins, 2002; Truong, Roe, & Bancroft, 2004). The syntax of programming languages is very complex (Gomes & Mendes, 2007). These languages were developed for professionals instead of novices. Programmers are required to memorize a lot of complex syntactic details. Students normally find it difficult to detect simple syntactical and logical programming errors. In order to tackle the difficulties, many researchers have proposed methodologies and tools, such as the use of peer assessment strategy, graphical languages and intelligent tutoring systems, to help students learn computer programming (Gomes & Mendes, 2007; Jenkins, 2002; Ng, 2012; Robins Rountree, & Rountree, 2003). However, the difficulty of learning computer programming is still an eminent problem that requires academics to develop effective teaching and learning strategies. In this connection, a blended learning approach that has been increasingly used in higher education would be a possible strategy to assist students to learn programming.

Blended Learning

Blended learning generally refers to the pedagogy that combines face-to-face classroom teaching with an online learning component (Sharma, 2017). The use of blended learning approach in designing courses, particularly in higher education, has been increasing (Mozelius & Hettiarachchi, 2017). With the inclusion of an online component, the time students spent on learning can be increased. A blended learning approach can make use of online technologies to implement asynchronous teaching and learning. Individual learning and learner autonomy can also be promoted by a blended learning approach (Mozelius & Hettiarachchi, 2017; Sharma, 2017).

As suggested by McAllister and Irvine (2000), teaching methods can be divided into two components, namely content-based teaching and process-based teaching. The main purpose of content-based teaching is for transmission of knowledge and skills. It is usually conducted using a lecture-based didactic approach for learning educational policies, procedures and theories (Grossman, 2005). The process-based teaching methods, on the other hand, provide opportunities for students to carry out reflection and initiate meaningful dialogue. They aim to engage students in active learning. In order to integrate content-based teaching and process-based teaching into a coherent pedagogy, a blended learning approach was adopted in this study with a face-to-face component for content-based teaching and a collaborative online learning component for process-based teaching. Details of the design are elaborated in the Method section.

Collaborative Learning

Collaborative learning that involves social interaction has been vigorously advocated by academics (O'Donnell & Hmelo-Silver, 2013), especially since the contribution of Vygotsky (1978). On the basis of Vygotsky's work, researchers have regarded education and cognitive development as cultural processes. They stressed that knowledge is not only possessed by individuals but also shared among members of communities. People jointly construct understandings by their involvement and interactions in events that are shaped by cultural and historical factors (Drummond & Mercer, 2003). Interactions between students reflect the historical development, cultural values, and social practices of the societies and communities in which education institutions exist (Drummond & Mercer, 2003). From the sociocultural perspective, learning occurs in the mental processes of social interaction and dialogue. Students can thereby learn by negotiating and collaborating with others (McLoughlin & Marshall, 2000). According to Vygotsky (1978), cognitive processes first appear at the social (*intermental*) level. These cognitive processes will then be internalized and transformed into individual ways of thinking, which are characterized as the *intramental* level (Fernandez, Wegerif, Mercer, & Drummond, 2001).

In Vygotsky's (1978) research on youngsters, he identified the zone of proximal development (ZPD) as "the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (p. 86). Vygotsky recognized that the ZPD is critical for learning and further suggested that the development process lags behind the learning process. In this concept, an essential feature of learning is to identify the ZPD and equip learners with the capacity to proceed to this zone. This requires the awakening of a variety of internal developmental processes for learning that only operate when the learner is interacting with people in his or her environment and in cooperation with his or her peers. Once these processes are internalized, what has been learned becomes part of the learner's independent development achievement (Vygotsky, 1978). The ZPD can also be characterized as the dynamic region where the intermental level converges with the intramental level (Fernandez et al., 2001).

An important feature of ZPD is to learn with the guidance of adults or more capable peers. In fact, collaborations between students who have similar levels of conceptual understanding can also promote learning. Fernandez et al. (2001) categorized two types of interactions. The interactions between teachers and students are "asymmetric" in form, while interactions among students are regarded as "symmetric." They defined the *intermental development zone* (IDZ) as a characteristic of a dialogical phenomenon created and maintained between people in interaction. They claimed that any joint, goal-directed task must involve the creation and maintenance of a dynamic, contextual basis of shared knowledge and understanding. Moreover, the success of any collaborative endeavor will be related to the appropriateness of the communication strategies participants use to combine their intellectual resources (Fernandez et al., 2001).

Actually, a number of researchers have adapted the social constructivist approach to deal with situations involving learners of more or less the same level of competence working on a task collaboratively (Littleton & Hakkinen, 1999; Ng, 2013). With the development of web technologies, it has been a common practice to integrate online collaborative learning activities in designing courses in higher education to enhance learning effectiveness (e.g., Brindley, Walti, & Blaschke, 2009; Lai & Ng, 2011). Therefore, it is reasonable to expect that the students would have better learning effectiveness if they are placed into online collaborative learning. In view of the difficulty of learning web programming, the researchers implemented a collaborative blended learning approach with the purpose to enhance learning effectiveness. This study attempted to explore the following research question: "What are the impacts of a collaborative blended learning approach in learning web programming?"

Method

The study was conducted in a course entitled Introduction to Web Technologies and Standards taught by the first author in a Bachelor of Education programme. This course provides students with fundamental concepts on Internet development, web technologies and standards. It also offers students the basic knowledge and skills of presentation, representation, query and transformation technologies on the Web. The course also gives opportunities to students to engage in hands-on experience in working with a variety of web technologies. Upon completion of the course, students should be able to develop fundamental concepts of Internet development and web technologies, demonstrate understanding on a wide range of web technologies and standards, and acquire basic skills of presenting, representing, querying and transforming information on the Web. A total of 25 students enrolled in the course, with 21 males and four females.

Collaborative Blended Learning Approach

The collaborative blended learning approach was comprised of a face-to-face teaching component and an online collaborative learning component. The face-to-face teaching component aimed to enable students to obtain conceptual knowledge and practical skills of web programming. Students were also provided opportunities to have hands-on practice to create webpages.

The first topic was Extensible Hypertext Markup Language (XTHML). It is the fundamental language of building a basic webpage. Students were then introduced to the language of Cascading Style Sheets (CSS) for formatting the styles of webpages. The next topic was JavaScript for creating dynamic functions in a webpage. The last topics were Extensible Markup Language (XML) and Extensible Stylesheet Language Transformations (XSLT) for dealing with data in webpages. At the end of the face-to-face teaching component, students were requested to participate in an online collaborative learning activity.

The purpose of online collaborative learning component was to engage the students in active learning outside classroom with collaborative efforts. The students were required to participate in two stages of learning activities. In the first stage, the students were randomly divided into four groups under the topics XHTML, CSS, JavaScript, and XML together with XSLT. Each student was requested to develop two multiple choice questions of a respective topic with a format specified by the lecturer for testing their peers on the knowledge of web programming. The students were encouraged to develop high-quality questions that were meaningful, challenging, without grammatical error, with reasonable choices and with only one correct answer.

The students were requested to send all the multiple choice questions to the lecturer individually via an online learning management system. After receiving all the questions, the lecturer reviewed the questions, made necessary amendments and then compiled a full set of multiple choice questions developed by the students for conducting the activity in stage two. The quality of the multiple choice questions would be evaluated to explore students' learning attitude in this activity. It was expected that students with better learning attitude would develop higher quality questions.

In Stage 2, the lecturer input all the questions into the game-based online quiz platform "Kahoot!" (Figure 1). This platform was designed with attractive interface and interactive features. It provided functions for the lecturer to implement an online quiz and track the performance of each student. The students were required to download the Kahoot! app and install it in their mobile devices. They were then requested to participate in the online quiz individually during a specific period of time outside the classroom using their own mobile devices. They were also informed that all the questions in the quiz were developed by students in the class. In this setting, they were arranged to learn in a collaborative approach. Their performance, including both the quality of the questions and their performance in the online quiz, counted 10% of the overall assessment of the course. Their performance in the online quiz would serve as a piece of evidence of their learning effectiveness of the overall strategy.

Figure 1. "Kahoot!" A game-based online quiz platform.

Results

As mentioned in the Method section, the quality of the multiple questions created by students and their performance in the online quiz was evaluated to explore the effectiveness of the collaborative blended learning approach implemented in this study. Respective results are reported in this section.

Quality of Multiple Choice Questions

Since there were 25 students in the class, a total of 50 multiple questions were created. Among all the questions, two questions were identified as having vague meaning and irrelevant choices of answers. These two questions were regarded as poor quality and were removed from the final online quiz. Regarding the remaining 48 questions, the number of questions on HTML, CSS, JavaScript and XML with XSLT were 12, 12, 14 and 10 respectively. There were 11 questions asking factual knowledge that simply required participants to choose the correct answer by recalling the contents covered in the course. The quality of this kind of question was regarded as relatively low since recall of knowledge was regarded as the lowest level of learning in Bloom's (1956) taxonomy of learning. A typical question was "What does XHTML stand for?"

Among all the multiple choice questions, 37 questions assessed participants' understanding on web programming. The quality of this kind of question was regarded as high since it was not to assess the ability to simply recall factual knowledge. It required the participants to have a good comprehension of the contents of web programming covered in the course.

A typical question is as follows. A summary of the quality of questions created by the students are given in Table 1.

What is the value of z after executing the following codes?

```
var y = 10;
var z = 0;
for ( var x = 0 ; y > x ; x++ ) {
        if ( (x%2) == 0)
                z++;
}
```

A. z = 2
B. z = 3
C. z = 4
D. z = 5

Table 1

Quality of the Multiple Choice Questions Created by the Participants

Quality of Question	No. of Questions	Percentage
Poor	2	4%
Low	11	22%
High	37	74%

Performance in Online Quiz

Regarding the students' performance in the online quiz, all the students participated in the activity. Among all the 48 questions, the number of correctly answered questions of each student ranged from 24 (50%) to 48 (100%). The mean and standard deviation were 39.7 (83%) and 5.8, respectively.

Discussion and Conclusions

As indicated from the results, a high proportion (74%) of questions developed by the students were regarded as high quality. This suggests that the students had obtained sufficient content knowledge for developing good questions for enhancing learning. They were also willing to contribute to peers' learning by paying efforts to design good questions. Their positive attitude toward the task was most probably due to the attitude change of identification suggested by Kelman (1958) that the students preferred to maintain a mutually supporting relationship. Under the setting of collaborative learning in this study, it appears from the results that the student regarded himself or herself as being similar to others or enacting a role reciprocal to that of other people. Students were then willing to expend efforts to design high-quality questions and to serve as good learning partners. This aligns with the opinion of Jung, Choi, Lim, & Leem, (2002) and his colleagues that peer collaboration are important in enhancing learning. Another possible reason of the high proportion of good questions might because the students enjoyed the design of the activity. They might find it interesting to challenge their peers by setting challenging questions. In this connection, more evidence collected in future studies might be required to explore students' attitude in the learning process.

On the other hand, the students had good performance in the online quiz and that provided some evidence of the effectiveness of the collaborative blended learning approach. Similar to the argument suggested by Mozelius and Hettiarachchi (2017) and Sharma (2017), the online component of blended learning had successfully encouraged the students to spend more time on learning. They were provided opportunities to learn individually with required autonomy. The result of good performance in the online quiz aligns with the findings from previous studies (Owston, York, & Murtha, 2013; Wu, Tennyson, & Hsia, 2010) that a blended learning approach could be beneficial to students' learning. However, since the sample size in this study was not large and there was no control group in this research, more related studies may be required to further confirm the effectiveness of the collaborative blended learning approach to enhance students' learning. With detailed elaboration, the researchers suggested a collaborative blended learning approach for enhancing the effectiveness of learning web programming in this paper for future reference.

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Author Details

Wing Shui Ng
ngws@eduhk.hk

Gary Cheng
chengks@eduhk.hk