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## Development of a problem-based learning model via a virtual learning environment



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### ABSTRACT

The primary objective of this research was the development of a problem-based learning model using a virtual learning environment (VLE) for undergraduate students in the Photography for Communication Arts course. The model supports and enhances students' learning, achievements and problem-solving skills. An efficiency test for the model revealed an above average set of criteria at 80/83.93, which conformed to the research hypothesis. The principles of instructional systems design (ISD) and systems approach were integrated into the design and assessment phases of model development, which resulted in more effective management of relevant instructional courses and materials. Based on its efficiency and potential application to real-life situations, the model has been deemed suitable by experts. The selected student group in the problem-based learning model via VLE achieved higher test scores compared to a group of students in a normal classroom with a statistical significance of .05. Because students learn using models that promote self-awareness and make it possible to choose their own topic of study employing resources provided by VLE, an assessment of their work quality found that they gained more knowledge of information technology as well as access to up-to-date information. Students are able to choose the most comfortable time to study. The model encourages students to learn through participation, practice problem-solving skills on an individual basis, and exchange ideas with other members of a group. The virtual environment involves many forms of media and materials that stimulate students' interest in learning and results in higher satisfaction. The gap in the communication channel between students and teachers is reduced due to easier and more informal communication.

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### Introduction

Problem-based learning (PBL) is a student-centered pedagogy in which students learn about a subject by attempting to find a solution to an open-ended problem. As found by research conducted by [Hmelo-Silver \(2004\)](#), students practice both thinking strategies and domain

knowledge. Problem-based approaches to learning have a long history of advocating experience-based education.

Psychological research and theory propose that having students learn through problem-solving experience allows them to learn the content as well as new thinking strategies.

PBL is also an active way for students to learn basic problem-solving skills and acquire knowledge through interaction with others, a key skill demanded by nearly every work environment. Students learn within small, self-directed groups to define and carry out specific tasks, either real-life or study-based. In research conducted by [Loyens](#),

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Kirschner, and Paas (2011), PBL represented a major development in educational practice that continues to impact courses and disciplines worldwide. The roots of PBL date back to the mid-1960s at McMaster University Medical School in Hamilton, Canada (Loyens et al., 2011).

According to Pumahapinyo and Suwannattachote (2014), various forms of technology are used to facilitate e-learning, with most applications using a combination of techniques such as blogs, collaborative software, e-Portfolios, and virtual classrooms. Particularly for higher education, an increasing tendency is to create a virtual learning environment (VLE) in which all aspects of a course are handled using a consistent and standard interface throughout the institution (e.g. Moodle, Schoology, Edmodo). This is consistent with Muñoz and Towner (2009), who suggested that students are heavily immersed in Web 2.0 technology (i.e. blogs, twitter, podcasts, wikis, social network sites, virtual worlds, video sharing and photo sharing). Educators are also turning to Web 2.0 tools, drawing upon their abilities to assist in creating, collaborating on and sharing content.

The cutting edge technology called Moodle's Learning Management System (LMS) was selected at Massey University, which was eventually renamed Stream. Today, LMS is used extensively for the delivery of blended learning for internal and distance-learning students across the vast majority of the university's courses and programs. As part of this process, the virtual learning environment has recently been integrated into the teacher's toolkit of teaching tools.

According to Oxford University Press (2015), a virtual learning environment (VLE) is a system for delivering learning materials to students via the web. These systems include assessment and student tracking features, as well as collaboration and communication tools. They can be accessed both on and off-campus, meaning that the system can support students' learning even outside the lecture hall, 24 h a day, 7 days a week.

In Thailand, Phanich (2012) suggested that younger generations of Thai people have characteristics that demand the freedom to select what they want in order to express their personal opinions and individuality. They consider play and enjoyment in conjunction with aspects of work, learning, and socialization. This involves the demand for rapid communication, the ability to search for information and answer questions, and the creation of innovation for everything in life. Therefore, the link between social network learning and 21st century skills has been proven (Greenhow, Robelia, & Hughes, 2009) and VLEs offer increased potential for resolving current educational problems.

## Literature Review

### *Problem-based Learning*

The more the focus is on developing students who can devise effective solutions to real-world problems, the more successful those students will become. This is what Crocket (2012) articulated for the 'Global Digital Citizen Foundation' with the concept of 'Solution Fluency', which concerns

solving complex problems effectively in real time using unique and carefully-designed solutions.

Etherington (2011) reported on the success of using a problem-based learning approach in teaching primary science, stating that it had replaced the traditional content-driven syllabus in 2010 for an evaluated group in New South Wales. It was also discovered that the PBL course had a positive impact on pre-service teachers' motivation to teach scientific ideas within a real world context.

In problem-based learning, students apply an 'inquiry method' to seek knowledge and solutions through the questioning and investigation of locations, objects, people, books, evidence and information. Therefore, a learning process can result from seeking a solution or setting a question that is collaboratively and carefully selected by a group of students and their lecturers. The problem is determined to be the starting point for the learning process, which motivates students to keep investigating so they can better understand the mechanics of the problem as well as the solution.

This is consistent with Newble and Clarke (1986), who concluded that problem-based learning leads to a deeper approach to learning. A significant amount of evidence supports the value of active and cooperative learning (Johnson, Johnson, & Smith, 1998).

An educational virtual classroom environment has been defined as one that affords the potential to carry out asynchronous and synchronous learning, while problem-based learning (PBL) is used as the process to implement the planned scenarios, such as case studies, as well as to aid learning in a multi-disciplinary or multi-skills context (Bignell & Parson, 2010).

Despite clear evidence, there is an ongoing debate concerning the usefulness of asynchronous versus synchronous e-learning (Hrastinski, 2008). Simply stated, asynchronous learning might be considered an older form of e-learning in 2016, with students using email or discussion boards as the medium of communication. This is because technology has 'moved on' with the advent of smartphones and 3G/4G standards, which have made synchronous learning and communication more commonplace around the world, including in Thailand. Discussion boards are being replaced with real-time, interactive learning management systems (LMS) such as Schoology and Moodle, or social networking tools such as Line.

While technological differences abound, social network sites (such as Line, WhatsApp) are 'web-based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system' (Boyd & Ellison, 2008).

In this new social era, learning and innovation skills are vital. Learners must seek self-training and development in an effort to enhance their skills. This 'learning by doing' technique prepares learners for their future careers (Sun & Kang, 2015). The skills comprise the 4Cs: Critical Thinking, Communication, Collaboration, and Creativity.

The Thailand National Education Act of B.E. 2542 (1999) stipulates that education should be focused on all aspects

for the full development of children and youth, including knowledge, morality, and learning processes so that they can sustain themselves in society and be capable of self-learning on a continuous basis into the future. Section 66 of the Act stated that Thai national policy is for students to have the right to develop their capabilities for utilization of educational technologies. Such utilization can provide sufficient knowledge and skills in using technology for the acquisition of knowledge on a continual and lifelong basis.

From a literature review of articles and researches concerning problem-based learning, it has been discovered that the learning model enhances the learning results of students. It also encourages self-study by using problems to encourage understanding as well as discovery, which allows higher quality and more efficient work to be produced.

#### *Virtual Learning Environments (Learning Management Systems)*

As previously established, VLEs can also be referred to as LMSs (Learning Management Systems). They are both technologically rooted in what is often referred to as the 'Web'. However, the 'Web' is not the same as the Internet, though the terms are often mistakenly used interchangeably. For the purposes of this research, the 'Web' is defined as any software that runs on the infrastructure known as the 'Internet'. Software on the 'Web' can take countless forms. For educational use, common software/platform names, including Moodle, Edmodo, Schoology, WordPress, and Google Apps for Education, are used frequently. This is the 'Web' for educators.

A VLE application gaining in popularity is 'Google Apps for Education', with [Kannarik \(2014\)](#) stating that it 'will take them (students) one step closer to living and thriving in a virtual world, not just while they are students here, but after graduating as well'. In another study by [Pumahapinyo and Suwannatthachote \(2014\)](#) concerning the factors affecting the innovation-decision making process in the adoption of an online graduate degree program, it was determined that there were nine factors affecting the implementation of e-learning programs, including: 1) public relations, 2) course quality, 3) learning support focusing on technical staff, 4) technology support, 5) ability for self-directed learning, 6) ease of use, 7) course flexibility, 8) learner support focusing on learning material and media, and 9) reliability of measurement and evaluation. It is interesting to note that these researchers also discussed the overlapping nature of the terminology and grouped online education, virtual education, and virtual learning environments (VLE) as 'learning platforms' ([Pumahapinyo & Suwannatthachote, 2014](#)).

[O'Donnell \(2012\)](#) explored students' perspectives on the transformations brought to higher education and specifically discussed VLE by the use of technology. From the research and responses received from students, it was clear that students believed that the use of technology in higher education beneficially transformed learning. Despite this, learning via technology will never replace a human educator. In essence, the benefits that can be achieved

through the use of technology are totally dependent on the ways they are employed pedagogically by an educator.

The literature review of articles and researches related to virtual learning environments found that the students in this study already possessed information technology and communication skills, meaning they possessed the ability to use social media effectively. VLE replaces and fosters tradition learning. Education nowadays relies on students being able to use online learning applications effectively.

After a review of the literature, the following research objectives were established:

#### **Research Objectives**

1. To study the situation and problems of traditional learning in order to restructure the development of a problem-based learning model to incorporate a virtual learning environment for undergraduate students taking the Photography for Communication Arts course.
2. To develop, improve and gain acknowledgement for the problem-based learning via virtual learning environment model.
3. To analyze the results of applying the problem-based learning via virtual learning environments model.

#### **Methodology**

The methodology section has been presented in a table format for easier visualization and understanding of the 3 phases in the research ([Tables 1 and 2](#)).

#### **Research Findings**

The researcher found that the results of Phase 1 demonstrated that students found it hard to be interested in learning materials and courses in class. However, the students' interest was piqued subsequent to implementation of the model. Students were trained to search for the answer to a question on their own. Using this model, students were compelled to search for answers on their own and, thus, able to retain what they learned for a longer period of time. There are various types of lessons that motivate students' learning. The internet provides students with the opportunity to interact with the lecturer and other students. Further, it reduces limitations associated with the place and time. The conceptual framework for the development of a problem-based learning via virtual learning environment model is illustrated in [Figure 1](#).

The research results from Phase 2 concerning the development of a 'Problem-based Learning via Virtual Learning Environment' model are shown in [Figure 2](#).

Two steps were utilized to achieve the results of the model efficiency test.

Step 1: The model efficiency test was performed by six experts, with three experts employed for problem-based learning, while the other three experts focused on virtual learning environment systems. An assessment form with a 5-rating scale was used. The results showed satisfactory performance on the problem-based learning side at an

**Table 1**  
Methodology

Equipment	Sources of information	Research process
Phase 1: To study the situation and problems of traditional learning in order to restructure the development of a problem-based learning model that incorporates a virtual learning environment for undergraduate students taking the Photography for Communication Arts course		
Guidelines for synthesizing relevant document and research	Relevant documents and research	<ol style="list-style-type: none"> <li>1. Study and synthesize theories, documents and researches that are relevant to the problem-based learning model and virtual learning environment</li> <li>2. Study the development process for the problem-based learning via virtual learning environment model</li> </ol>
Report forms to evaluate learning situations for the 'problem-based learning via Virtual Learning Environment' model and learning problems in the Photography for Communication Arts course	<ol style="list-style-type: none"> <li>1. Five lecturers, consisting of four males and one female, teaching the Photography for Communication Arts course at Kasem Bundit University, each with more than 5 years of teaching experience</li> <li>2. Thirty undergraduate students in the Faculty of Communication Arts, Kasem Bundit University, taking Photography for Communication Arts during the 2556 (2013) academic year were selected through Purposive Sampling. School records were used to classify students into groups: Ten students who received an A grade, ten students who received a B or a B+, and ten students who received a C or C+. Male-to-female ratio was approximately equal</li> </ol>	<p>Study the current educational model and develop a learning model for undergraduate students in the Photography for Communication Arts course by in-depth interview and analyzing the received results</p>
Phase 2: To acknowledge and improve the model for problem-based learning via virtual learning environment		
<ol style="list-style-type: none"> <li>1. Draft of the problem-based learning via virtual learning environment model</li> <li>2. The model's analysis tool</li> <li>3. Assessment form for lessons conducted in the 'problem-based learning via virtual learning environment' model</li> </ol>	<ol style="list-style-type: none"> <li>1. Three virtual learning environment experts</li> <li>2. Three problem-based learning experts</li> </ol> <p>Pointing out experts depends on their expertise and their field of knowledge. In this case, their knowledge on virtual learning environment and problem-based learning</p>	<ol style="list-style-type: none"> <li>1. Design and development of the learning model</li> <li>2. Develop a learning management plan for the Photography for Communication Arts course that is relevant to the model, followed by an efficiency test</li> <li>3. Develop content for the course suitable for the problem-based learning class, followed by an efficiency test</li> <li>4. Develop a virtual learning environment system suitable for problem-based learning, followed by an efficiency test</li> <li>5. Develop a data collection tool</li> </ol>
Hypothesis testing tool	Forty two undergraduate students from the Faculty of Communication Arts, Kasem Bundit University, taking the Photography for Communication Arts course during the 2013 academic year were selected through Purposive Sampling. Their first semester GPAs (Grade Point Average) were used to classify them: Fourteen students were selected for their high GPA, fourteen students were selected for having an average GPA and fourteen students were selected due to having a low GPA. Male-to-female gender ratio was approximately equal	The model's efficiency testing is demonstrated in <a href="#">Table 2</a> .
Model acknowledgement form	<ol style="list-style-type: none"> <li>1. Three virtual learning environment experts</li> <li>2. Three problem-based learning experts</li> </ol>	Acknowledge the model
Phase 3: To study the results after use of the problem-based learning via virtual learning environment model		

**Table 1** (continued)

Equipment	Sources of information	Research process
1. Learning assessment test 2. Problem-solving skills test	Sixty undergraduate students from the Faculty of Communication Arts, Kasem Bundit University taking the Photography for Communication Arts course during the 2557 (2014) academic year were (2 groups of students had been selected by the selection method of Cluster Sampling) Group 1: Thirty students in the trial class with the problem-based learning via virtual learning environment model Group 2: Thirty students studying problem-based learning in a normal classroom	1. Group 1 studies using problem-based learning models within the virtual environment. Students can choose to learn whenever they desire to within 4 weeks, from a total of 4 lessons. After that, students are required to do the Learning assessment test and problem solving skills test. Group 2 learns within an ordinary classroom, in front of the teacher and other students. They are given 4 weeks, learning once per week, 4 h per lesson for a total of 4 lessons. After that, they are required to do the Learning assessment test and Problem-solving skills test 2. Compare the results of both groups and analyze with t- test dependent

average of 4.4. The research results also demonstrated very good performance on the virtual learning environment side with an average of 4.6.

Step 2: The model's efficiency test, using the Large Group Evaluation method with sampling, showed that the

efficiency of the problem-based learning via virtual learning environments model met the standard with a scale of 80/83.93 (the standard scale is 80/80, with the first 80 being the set standard and the latter 80 being the average score received).

**Table 2**

Efficiency testing process for the problem-based learning via virtual learning environment model

Equipment	Sources of information	Research process
Online lesson in virtual learning environment	Purposive Sampling selects students with a good learning record, those with an average learning record and those with a weak learning record. (School records were used to classify students into groups of students who received an A grade, those receiving a B or a B+, and those receiving a C or a C+. Male-to-female ratio was approximately equal)	Students are required to do a trial run of the problem-based learning via virtual learning environment model without class assessment. Round 1 uses the 'One-to-One' evaluation method with 3 students as the sample 1. Students participate in the lesson while their behavior is observed by the researcher regarding their readiness, interest, and choice of communication channel 2. The researcher asks for feedback from the students about the lesson
Online lesson within virtual learning environment	Nine sample students: Three with a good learning record, three with an average learning record, and three with a weak learning record (Sample students from the 'One-to-One evaluation' process were not selected)	After improvement of the learning materials following the first round of data collection, Small Group Evaluation will be conducted with 9 samples 1. Observe and record student behavior while on the trial run 2. Students participate in the lesson while their behavior is observed by the researcher regarding their readiness, interest, and choice of communication channel 3. The researcher asks for feedback from the students about the lesson
Quality assessment form to access online lessons within the virtual learning environment	1. Three problem-based learning experts 2. Three virtual learning environment experts In this study, 5-point Likert scales were used to measure the level of agreement with a given statement as they are able to generate a higher degree of dispersion as well as minimize neutral responses. The responses ranged from (1) strongly disagree to (5) strongly agree)	1. The researcher brings an improved model to perform a quality assessment of problem-based learning via virtual learning classroom experts 2. The results are brought for analysis of statistics 3. Average rating score of the assessment by six experts and Standard Deviation
1. Online lesson within virtual environment 2. Testing paper	Ten students with a good learning record, ten students with an average learning record and another ten students with a weak learning record	1. The researcher brings an acknowledged model for use in a real classroom with sample students over 4 weeks. This is called a 'Large Group Evaluation' 2. Students are required to do the test 3. Analyze the data with the t-test dependent

Note: The study of a sample group at Kasem Bundit University was approved by an institutional review board

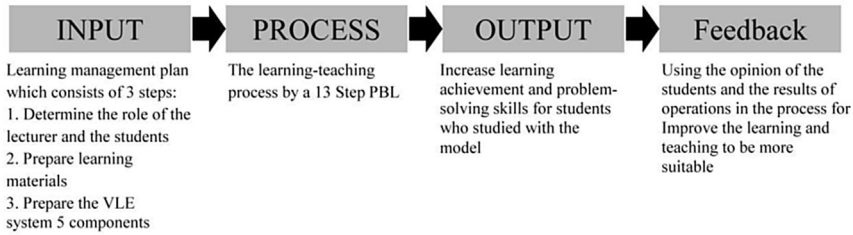


Figure 1 The concept framework for the problem-based learning model in a virtual learning environment

The research results after Phase 3 were obtained subsequent to the problem-based learning via virtual learning environment model being tested with undergraduate students in the Photography for Communication Arts course. The class was split into 2 groups comprised of a virtual learning environmental class and a normal class, with the normal class acting as a control variable. The research found a difference in learning ability between the two. Students in the class utilizing problem-based learning via virtual learning environments received a higher average learning score with a statistical significance of .05

when compared to students undertaking problem-based learning via a normal classroom, as demonstrated in Table 3.

From the test's hypothesis using t-test statistics to compare the difference between the independent variable of the two groups, including the group that participated in PBL via normal classroom and the group in an ordinary classroom, it was found that the t-value was 5.512, while the p-value was .27, which is less than statistically significant at .05. This means that the hypothesis is acceptable. The learning result for the PBL via VLE group was higher

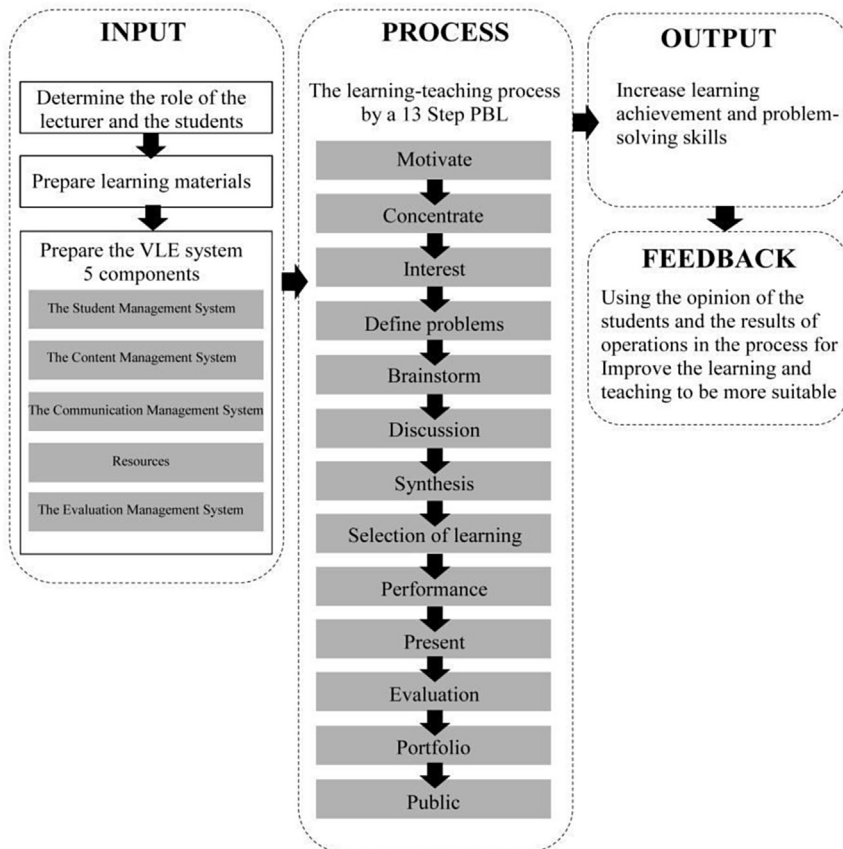


Figure 2 Problem-based learning model in a virtual learning environment

**Table 3**

Comparison of students in the problem-based learning via virtual learning environment model and students in the problem-based learning via normal class

Group	n	$\bar{x}$	S.D.	t	p
Students taking the PBL via VLE class	30	24.53	1.697	5.152	.27
Students taking the PBL via normal classroom	30	21.73	1.143		

than the result of the PBL via normal classroom group with a level of statistical significance at .05.

## Conclusions and Discussion

The results showed that problem-based learning via a virtual learning environment enhanced learning ability and problem-solving skills among students in the Photography for Communication Arts course. Student feedback toward the model was positive, as it followed their interests and used problem solving to stimulate learning. The group work aspect tended to make them feel free of the classroom. The model was inspired by studying the concepts, theories, documents and relevant researches on problem-based learning via a virtual learning environment. Subsequently, guidelines for learning activities were created by analyzing the main concepts of the developed model. This was followed by developing the processes for learning and teaching, as well as by measuring and assessing the learning format.

### Input

#### Determining the Role of Students and Lecturers

Determination of students' and lecturers' roles in the classroom is essential for maximizing the effectiveness of the model. The role of the student is the most vital and affects how learning is accomplished. Students have the task of deciding what and how they want to learn following the concept of 'self-study'. This means students have to manage their own time efficiently and be invested in every step of the learning process. There are several studies on self-control supporting the importance of a well-structured problem-solving process (Ge & Land, 2003; Shin, Jonassen, & McGee, 2003). Referenced studies have been conducted in various situations such as regular classrooms, hypermedia environments and web-based e-learning environments, all of which demonstrated the relationship between self-regulation and learning outcomes. The role of a lecturer in the model is to establish and manage instructional courses and materials in addition to arranging plans for students to be ready for class. Lecturers facilitate and advise students in an attempt to persuade them to study using their full ability. Siemens (2005) explained that lecturers are the supporters of learning and instrumental in the learning management of students. Meanwhile, the Virtual Learning Classroom will be the center of students' learning management and ensure they work in groups to maintain learning progress.

#### Lesson Preparation

Problem-based lessons have to be challenging for students to stimulate their curiosity and facilitate their

interest. The model has been developed from the idea of learning by doing (self-study). Students will be allowed to choose problems they find interesting and attempt to solve them. Subsequently, they solve the problem and disseminate the successful solving procedure, which leads to the development of their problem-solving abilities. Students can even attempt learning activities that seem beyond their abilities. The model reduces failure with every operational step. As a result, students can achieve self-learning and eventually meet their instructional objective.

#### Preparation for a Virtual Learning Environment System

A virtual environment in internet-connected network learning is set up for lecturers and students to interact online as if it were a normal classroom. Students interact with each other and the lecturer through social media. The five-component virtual learning environment (VLE) consists of the following:

1. **The Student/Learning Management System (SMS/LMS)** developed for the study helped manage all student information, including their personal profiles, activity progress reports, a student logging report, and a student progress report. Moodle LMS was used for the study as it is open source. Moodle LMS operates on computers as well as smartphones, though most students nowadays access information from the internet with smartphones. Conforming to statements made by Chana, Walkerb, and Gleavesb (2014), young people are engaging with their smartphones everyday. Therefore, learning occurs constantly as it is interwoven with mobile practices. These new types of learning are different from learning in a traditional classroom setting, but they are enabling learners to navigate the structures and meanings of the online world for the transposition of skills and knowledge into the 'real' world.
2. **The Content System** contained instructional documents and programs, such as Adobe Acrobat and Desktop Author, which were used to create e-Book content and animated demonstrations for a series of activities. Lecturer demonstrations were performed through the use of YouTube Live Streaming.
3. **The Communication System** allowed students to collaborate with each other through a synchronous medium, namely a chat room, when they were online (Hrastinski, 2008). Facebook was also employed as a tool to communicate individually or in group discussions. Recent technological improvements in telecommunications have created additional opportunities for online applications. One major development of web applications, Web 2.0, was the birth of social networking sites (SNS). Examples of such SNS are Myspace, Facebook, LinkedIn, Twitter, Flickr, Instagram, and WhatsApp. SNS promote interactions and allow users to communicate information and experiences instantaneously (Boyd & Ellison, 2008).
4. **Resources** included the website containing course content generated by lecturers and students, such as animated working processes relevant to classroom lessons. Kyei-Blankson and Ntuli (2013) established a link

between active learning (i.e. were the assignments 'interesting' and 'fun') and course satisfaction.

5. **The Evaluation System** focused on the students' portfolio, which was a collection of accomplished work, reports, assignments, and activities recorded and published both in the form of books and online content. Mahara's ePortfolio system for files was also used to supplement Moodle's LMS.

### *The Process of Problem-based Learning*

#### *Motivate*

This step prepared students to understand what they were learning and how to effectively utilize the knowledge gained, while at the same time creating activities that helped enable students to understand lesson objectives more clearly. This is especially true for the course introduction, which is a very significant activity because subsequent learning activities can be successful if the course introduction goes well.

#### *Concentrate*

This step focused on the student's concentration and determination to learn. Students needed to concentrate on learning so that they could understand lessons, have better memory, learn faster, and successfully use ideas in doing their assignments. This is consistent with Wong (2015), who stated that successful students concentrated on learning the information, not on trying to get a certain grade. Creating a virtual classroom environment fully equipped with necessary tools and resources for studying and researching as well as setting times for answering questions within a determined time are included in this step.

#### *Interest*

Keeping students interested in the classroom and the material being taught makes students want to learn and also makes lecturers feel confident to teach. To make students want to learn, a problem or case study must be interesting enough and have many possible solutions so that students can express their opinions and creative ideas. Sample situations similar to a given problem can be used to guide students through solutions without directly giving them the answer.

#### *Define Problems*

Defining problems was like a mind map enabling students to apply information in finding an answer.

#### *Brainstorm*

Sharing opinions among students lead the way to action planning and finding the causes of problems. This is part of cooperative learning, which is an educational approach that aims to organize classroom activities into academic and social learning experiences. Presently, many students use SNS to share information and knowledge, collaborate to complete homework assignments or projects, and discuss concepts and ideas. For example, students have used Facebook groups as a learning management system (Wang, Woo, Quek, Yang, & Liu, 2011). The use of SNS has gained

popularity among students (Chu & Meulemans, 2008), finding that the majority (90%) of Myspace and Facebook used it to communicate with others about school, professors, or courses.

#### *Discussion*

Discussion is very similar to brainstorming in that it is a method that allows both the lecturers and students to hold discussions, share opinions, and brainstorm ideas to solve a problem. This helps enable students to think and speak properly (Daft & Lengel, 1986) to investigate the effect of online discussion forums on learning. The research found that the perceived richness of online discussion forums has a significant positive effect on student interaction and learning.

#### *Synthesis*

Synthesized thinking can help students create innovation, while synthesized information is useful for expanding knowledge and helping students to apply others' ideas or practices to further develop them without starting from scratch.

#### *Selection of Learning Issues*

To decide a solution, group members have to join a meeting to consider the most accurate hypothesis for problem-solving by taking into account the synthesized information. If there is more than one seemingly accurate hypothesis, students are required to rank them according to probability.

#### *Performance*

After passing the above processes, students were allowed to perform or take action. If there was any problem, lecturers would give comments and offer suggestions. This helped make students more confident and gave them the opportunities to concretely apply their knowledge to their work.

#### *Present*

Students presented their work in this step. After the presentation, lecturers and students discussed the learning processes gained from theory and practice. Additionally, there were Q&A sessions to talk about opinions, which lecturers subsequently summarized in an effort to help students understand what they had learned as well as give them advice on applying what they had learned.

#### *Evaluation*

Various kinds of evaluation were implemented. After students presented the solution or problem-solving approach via a chat room lesson, lecturers would evaluate not only their knowledge or finished work, but also the acquisition process.

#### *Portfolio*

Portfolio was a systematic collection of basic personal data and work resulting from actual practices, which was beneficial to learning development. Trace evidence clearly reflected the real ability of each portfolio's owner.



## Public

In the final step of the study, publishing final projects and work through online social media was a way to publicly present students' work. This allowed others to view, comment on, and offer suggestions, while asking and answering questions at the same time.

## Output: Student Learning Achievement

The results from testing the problem-based learning model via virtual learning environment in the Photography for Communication Arts course revealed that the learning achievement of students using the problem-based learning model via virtual learning environment saw a higher average score than students using the problem-based learning model via a normal classroom with a statistical significant of .05. The results conformed to the hypothesis. Students realized their own capabilities, while choosing what they wanted to learn by themselves when they were ready, with encouragement from the lecturer. The model allows students to both think independently and as a member of a group with other students. The model emphasized a hands-on approach in each step. John Dewey (1985), a well-known academic figure, believed in the learning philosophy that humans have to adapt in order to survive. 'Learning by doing' is a famous phrase often carried out practically in education management. The lecturer plays the role of an adviser, encouraging students to independently think instead of relying on rote memorization.

## Feedback

The research accepted feedback from students and the results of operation in each step in an effort to improve learning management for suitability. The research found that most students were more satisfied with learning using the model than in a normal classroom. With the model, students stated they felt free to learn and experiment independently, while also communicating comfortably with their lecturer and friends when questions arose. Notably, communication was conducted through social networking sites such as Facebook. This corresponds to several other studies (Kumar & Rajendra, 2012; Sri Jothi, Neelamalar, & Prasad, 2011), which stated that online social networking software provides a better learning environment through increased interaction and online discussions. For example, Facebook provides an easy-to-use tool for interaction and allows the instantaneous exchange of information to occur anywhere at any time, among students as well as between students and lecturers.

There are several knowledge-providing media forms, including pdf as a data file, videos to teach the various steps of work, and streaming in real time to make students feel as if they are learning with a real lecturer. The learning model focuses on the problem-solving process, which trains students to solve problems using knowledge–investigation processes. Hence, it prepares students to conduct self-study, which develops into continual learning.

## Suggestions for Further Research

1. Study and compare the suitability of various teaching materials used for PBL via VLE learning.
2. Study learning activities in PBL learning via online social networks, one of many sources of knowledge acquisition, since students currently use social networks on a daily basis to communicate and search for information.

## Conflict of Interest

There is no conflict of interest.

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