An Inquiry blended SECI Model-based Learning Support Approach for Promoting Perceptions and Learning Achievement of University Students

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Abstract—Both inquiry-based learning approach and SECI (Socialization, Externalization, Combination, and Internalization) model of knowledge management are necessary elements for developing learning support environment to university students. Therefore, this study proposed an inquiry blended SECI model to scaffold university students through knowledge sharing, internalization, and inquiry-based learning processes. An online learning support system was developed basing on the proposed inquiry blended SECI model and implemented in a web-programming course. Ninety-one university students were recruited to participate in this study. The experimental results showed that the university students who learned with the proposed system had better perceptions toward the learning support system and better learning achievement than those who learned with the traditional learning support system.

Keywords—computer science education; online learning; knowledge management; scientific inquiry

I. INTRODUCTION

Student-centered learning requires the utility of educational media, innovation, and technology to help improve learner's involvement and interaction with the corresponding media [1]. Therefore, the use of the learning media consisting of innovation and new technology will build interesting learning environment. It means that the learning media is still the learning source for supporting students’ learning in everywhere. In doing so, teaching and learning web-programming course is also required the students-centered learning environment. Web-programming provides students with critical thinking and problem-solving skills and promotes rational, systematic and creative thinking for them. Web-programming course is a compulsory subject for university students. The course aims to equip students with an understanding and knowledge on the principle of fundamental website development beginning from HTML, CSS, PHP language and the use of MySQL to connect with database.

In recent years, most existing online learning systems have been proposed for promoting web programming performance [2][3][4]. However, they have been developed basing only on inquiry-based learning or knowledge management model [5][6][7][8][9]. Knowledge sharing and fostering students to construct knowledge by themselves are significant. Because knowledge is always fuzzy and messy, and the knowledge construction process involves sharing knowledge and constructing knowledge by themselves. Therefore, effective knowledge construction should be achieved via an inquiry blended knowledge management process rather than an individual constructing knowledge process. The inquiry blended knowledge management will demonstrate the student-centered learning environment in which the students are allowed to build their own body of knowledge.

Given the current emphasis on teaching web programming concepts in higher education as well as the rapidly evolving theories and practices of web-based learning systems in recent years, the goals in this study were to 1) develop online learning support system with an inquiry blended knowledge management process to encourage and foster knowledge inquiry, knowledge sharing and knowledge internalization; 2) implement the developed online learning support system in learning web-programming; and 3) to investigate whether there were difference of university students’ perceptions and learning achievement during the learning process. The originality of this study would enhance the understanding of the development of online learning support system and enhance the online learning support success of the university students in learning web programming.

II. RELATED RESEARCH

A. Inquiry-based Learning Process and Online Learning Support System

Prince and Felder defines inquiry-based learning as ‘inductive’ approaches to teaching which covers variety of
teaching approaches such as inquiry-based learning (IBL), problem-based learning (PBL), project-based learning, case-based teaching or even discovery learning itself [10]. IBL is one of approaches that assist students in building body of knowledge commencing by questioning, observing to interpret assigned or actual questions. They then study information and problems and analyze for core problem in order to search from answers by themselves with teacher’s advice on approaches and principles.

Bianchi and Bell [11] clearly describes the different levels of IBL. Level 1: Confirmation Inquiry which is an investigation of knowledge that make students investigate knowledges or concepts to confirm known knowledge or concepts. Teachers are the ones who identify problems and answers or body of knowledge that students are expected to discover. Students are expected to follow specific activities. Level 2: Structured Inquiry which is knowledge investigation that makes student discover new body of knowledge themselves. Teachers are the ones who identify problems and demonstrate or explain the investigation. Students are to follow the investigation as instructed. Level 3: Guided Inquiry which is knowledge investigation that makes students discover new body of knowledge themselves. Students identify the problem and teachers supervise the investigation process and provide pieces of advice on investigation. Level 4: Open/True Inquiry which is investigation of knowledge that make students discovery new body of knowledge themselves. Students are given freedom to think, to identify problems, design and conduct investigation themselves.

Several online learning systems have been developed with IBL. It was found that the systems could enhance and motivate the knowledge acquisition and construction of students leading to improve learning performance [5][6][7]. However, such systems could not facilitate exchanging knowledge among individual students well enough. It would be better if the systems could provide the opportunity for the students to share knowledge and allow them to combine exchanged knowledge into their own meaningful knowledge.

B. Knowledge Management and Online Learning Support System

Knowledge management is a type of management that aims to promote exchange of knowledge among personnel within an organization. In order to complete each of personnel’s existing knowledge, the exchange is used to create innovation for problem solving or to develop works [10]. In addition, knowledge management is a process in which knowledge is established, codified, disseminated and utilized to enhance working efficiency [11]. Moreover, it is based on an approach that perceives personnel as the most valuable asset of an organization. Personnel is believed to be core resources contributing to the achievement set by the organization. In the current pace of the world we live in, knowledge-based economy drives the growth and creates job in every field of industry. An organization is dependent on its internal learning cycle to secure competitive advantages. Organizational learning cycle is an organized systematic process for searching, creating, collecting, disseminating, conveying, sharing and implementing of knowledge.

In the past years, several researchers have applied knowledge management on trainings and lectures. For example, Yu-chu Yeh [8] expressed that application of knowledge management model focusing on knowledge sharing, knowledge internalization and knowledge co-creation along with critical thinking contributes to and facilitates success of tertiary level education. Baskerville and Dulipovici [9] employed SECI model of knowledge conversion. The SECI model, which is one of knowledge management tools, internally builds knowledge within learners. Learners can create and share such knowledge to the others. These are considered fundamental of collaborative learning.

The SECI model defines “socialization” as a social interaction where experienced individuals transfer their knowledge to another individual or a group of individuals directly through imitation and practice. Such tacit knowledge attempt to transform such knowledge into explicit knowledge through the process of “externalization”. Individuals then exchange and combine explicit knowledge with the use of means such as documentation, computerized system and other information and technologies in communications through the process of “combination”. Finally, knowledge from the process of socialization, externalization and combination will become a part of individuals’ new innovative knowledge through the process of “internalization”.

From the above mentioned related research, online learning support system, which integrates SECI model, should be a method for develops students’ learning performance during inquiry-based learning process.

III. DEVELOPMENT OF INQUIRY BLENDED SECI-MODEL APPROACH BASED ONLINE COMPUTER PROGRAMMING LEARNING SUPPORT SYSTEM

Based on the concept of SECI model and inquiry-based learning process, an inquiry blended SECI-model approach was proposed. The approach composes of knowledge inquiry, knowledge sharing, and knowledge internalization. During the learning process, students’ activities are group-work and group-discussion to solve questions provided by lecturers. Community building, team work, observation-oriented learning and group discussion are all vital and relate to knowledge sharing. Self-reflection and self-understanding, conscious learning, repetitive skill practing, and discursive participation with other members are components of knowledge internalization.

From the proposed approach, this study developed an online learning support system. In this system, there is integrating of the inquiry-based learning approach and knowledge management: SECI model in order to serve web programming concepts of basics of PHP, saving and retrieving data, introducing selection structures, and PHP function. The learning support system was developed in order to prepare the basic information including exercises for each content in order to make the student to train to do and search the information by himself/herself that will help the students to understand the basic idea of web programming with PHP language.
Operating learning activities in the proposed learning support system are shown in five stages as follows:

A. 1st Stage: User Identification

Each student is required to identify himself/herself before accessing the system with username and password as shown in Fig. 1. This could help the teachers identify each student’s learning log file. Such that, the teacher could monitor learning progression for each student.

![Fig. 1. Login screen](image)

B. 2nd Stage: Proposing Individual Computer-programming Session

When student is successfully logging into the system, individual students will be asked to solve problem provided by teacher in the learning support system. The system asks each student to select the lesson unit related to web-programming content. Each student will find the question and the basic information corresponding with selected lesson unit. Afterwards, the student is asked to start programming in the specified code editor area to answer the open-ended inquiry question. He/she could see additional information related to questions during answering as shown in Fig. 2. When finishing programming, the student will be asked to submit his/her answer to the group computer-programming session for further discussion.

![Fig. 2. Individual computer-programming screen](image)

C. 3rd Stage: Group Computer-programming Session

In the group computer-programming session, each student will see answers/computer programming provided by other three members in each group. Moreover, the student can use annotation system to inquire or give the recommendation into the answer/computer programming to other members as shown in Fig. 3(a). In this stage, the students can use the chat room in order to communicate and discuss about the strengths and weaknesses of their own and peers’ programming. When finishing group discussion, members in each group are asked to create the best solution/computer programming. In doing so, each student is asked to vote programming meaning that the best computer programming will be selected to be the group answer/computer programming as shown in Fig. 3(b). In addition, the group programming will be delivered to the whole-class discussion.

![Fig. 3. Group computer-programming screens](image)
D. 4th Stage: Whole-class Computer-programming Activity

In the whole-class computer-programming activity, the teacher will show answers/computer programming of every groups to the class for further discussions. The teacher and students will discuss together about strengths, weaknesses, and limitations of programming. This stage might help students understand various methods for coding in the same problem.

E. 5th Stage: Revising Individual Computer-programming Session

After finishing whole-class discussion, each student received additional recommendations of computer programming corresponding to the question/problem. The teacher will open the system to provide the opportunity for each student to revise his/her computer programming once again as shown in Fig. 4. It means that this stage allows each student to construct his/her knowledge of computer programming by applying knowledge gained from the 3rd and 4th stages.

Fig. 4. Revising computer-programming area of each student

IV. EXPERIMENT AND RESULTS

In order to examine the effectiveness of the developed system, an experiment was conducted with ninety-one university-students. The students were divided into two groups (i.e. the control group and the experimental group). The experimental group (EG) included 47 students, while the control group (CG) had 44 students. In this study, the same teacher taught the students in the two groups in order to avoid the influence of different experienced teachers on the experimental results. The students in the control group learned with the traditional learning support system using Adobe Dreamweaver to coding individual lab assignments, while those in the experimental group learned with the developed system.

Before the experiment, the students took the pretest for evaluating their prior knowledge of web programming. The learning activities designed for 4 hours. The learning content for both the experimental and the control group was the same as basics of PHP, saving and retrieving data, introducing selection structures, and PHP function. After completing the learning activities, a post-test was conducted; moreover, the students were asked to respond the questionnaire to elicit their perceptions towards learning activities.

A. Results of the Questionnaire

After completing the learning activities, all students took the same 5-point Likert scale questionnaire for 10 minutes. The questionnaire is ranging from 1 ‘strongly disagree’ to 5 ‘strongly agree’. It was aimed to investigate the students’ perceptions after participating in the learning activities. The questionnaire items were intended to assess the perceptions on key features of online learning support system [12]. The revised questionnaire was piloted and obtained accepted reliability with Cronbach’s alpha of 0.93, implying that it is reliable. It consisted of nineteen items, which included three items on user-interface-design dimension, six items on perceived usefulness dimension, five items on perceived ease of use dimension, three items on attitude dimension, and two items on intention to use dimension.

<table>
<thead>
<tr>
<th>Questionnaire items</th>
<th>EG (N=47)</th>
<th>CG (N=44)</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>User interface design</td>
<td>Mean (SD)</td>
<td>3.73 (0.77)</td>
<td>Agree</td>
</tr>
<tr>
<td>Perceived usefulness of learning support system</td>
<td>Mean (SD)</td>
<td>3.87 (0.67)</td>
<td>Agree</td>
</tr>
<tr>
<td>Perceived ease of using learning support system</td>
<td>Mean (SD)</td>
<td>3.77 (0.66)</td>
<td>Agree</td>
</tr>
<tr>
<td>Attitude</td>
<td>Mean (SD)</td>
<td>3.97 (0.65)</td>
<td>Agree</td>
</tr>
<tr>
<td>Intention to use learning support system</td>
<td>Mean (SD)</td>
<td>3.66 (0.76)</td>
<td>Agree</td>
</tr>
</tbody>
</table>

As shown in Table I, the students in EG were satisfied with the developed system as a learning assisted tool, with the learning contents, and with the useful PHP basic information. Moreover, they felt that the developed online learning support system was a useful learning system during the web-programming learning activities. Thus, EG had been more...
positive perceptions regarding their perceptions of the ease of use the learning support system and their attitudes better than CG had.

B. Results of the Conceptual Pretest

The conceptual pretest aimed to measure the prior knowledge of the students in a web-programming course. It consisted of 20 multiple-choice items, each of which was scored one point, with the aim of testing the students' prior knowledge related to the content of the web-programming course. This test was developed to cover PHP Function of the web-programming course including basics of PHP, saving and retrieving data, introducing selection structures, and PHP function. The participants had never done this test before participating in the experiment. The results of the Kruskal-Wallis test showed that there was no significant difference between the two groups of students, with p = 0.989 and p > 0.05, indicating that the two groups of students had equivalent prior knowledge of web programming.

Table II shows the t-test results of the conceptual pretest. It is found that the test scores of the EG and CG did not significantly differ, with t = 0.989 and p > 0.05, indicating that the two groups of students had equivalent prior knowledge of web programming.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean (SD)</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>EG</td>
<td>13.02(2.345)</td>
<td>0.989</td>
<td>0.163</td>
</tr>
<tr>
<td>CG</td>
<td>11.218(2.461)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: EG – Experimental Group: participating in an online learning support system based on inquiry blended SECI-model approach; CG – Control Group: participating in a traditional learning support system based on Adobe Dreamweaver.

C. Results of the Conceptual Posttest

The conceptual posttest was employed to compare the learning achievement for the web-programming knowledge of the EG and CG after completing the developed online learning support system based on inquiry blended SECI-model approach and traditional learning support system using Adobe Dreamweaver, respectively. To explore the learning achievement between two groups, an ANCOVA on the posttest scores with the pretest score as the covariate was used as shown in Table III. It was found that the EG achieved significantly better achievement than the CG with $F_{(1,89)} = 10.503$ and $p < 0.05$. It implies that the learning achievement of the EG was greater than that of the CG because of the developed online learning support system based on inquiry blended SECI-model approach.

Table III shows the ANCOVA results of the posttest achievement scores for the two groups of students.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean (SD)</th>
<th>Adjusted mean</th>
<th>Std. error</th>
<th>$F_{(1,89)}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>EG</td>
<td>13.02(2.345)</td>
<td>12.839</td>
<td>0.347</td>
<td>10.503*</td>
</tr>
<tr>
<td>CG</td>
<td>11.02(3.534)</td>
<td>11.218</td>
<td>0.358</td>
<td></td>
</tr>
</tbody>
</table>

Note: EG – Experimental Group: participating in an online learning support system based on inquiry blended SECI-model approach; CG – Control Group: participating in a traditional learning support system based on Adobe Dreamweaver.

* $p < 0.05$

V. DISCUSSIONS AND CONCLUSIONS

This study analyzed the perceptions and learning achievement of an online learning support system based on inquiry blended SECI-model approach at second-year students’ learning of web programming course on PHP function topic. This study showed higher positive perceptions in the experimental group than in the control group. Furthermore, the group of students using the developed system had scored better in posttest than the group using conventional method. There are reasons to support these findings. Because the annotation tool and group computer-programming tool within the developed system allow the students in the experimental group to acquire hints or guidance during coding the program, while those in the control group used generally editor for programming without any supporting tool for discussion. This result is in line with research [13] that students will have positive attitudes and then they will accept to use the system. Once the students have positive perceptions on the novel system for learning web programming, they can perform better learning achievement than a student who did not receive the proposed system.

Consequently, we could suggest that the proposed approach could be support perceptions and learning achievement in the web programming course. This research provides in-depth information for education in web programming course for higher education. Moreover, it suggests that a proposed approach could be provided for more perspectives in smartphone or mobile device platform either IOS or Android to offer alternative learning channels. Such that, the students could be better access to knowledge regardless of time and location with teachers’ ability to follow-up.

VI. Future Work

In the next phase, the research is intending to develop the knowledge-inquiry and knowledge-management (KI-KM) system by using mobile responsive platform connected with wireless communication. The KI-KM has been developed basing on the inquiry blended SECI-model approach of this paper. However, the KI-KM would be better to offer students with extracurricular self-practicing without the needs of computers in a laboratory room. This learning support system will enable students to practice via smartphones, tablets, and notebooks at all times. It will be improved the system’s efficiency by designing of KI-KM learning system on a mobile device. This system will be able to work well both with computers and all smart devices without the need to develop new systems, which is the advantage of designing system in the form of responsive web design.

When the KI-KM have completely developed, the effectiveness of the system will be need to be evaluated. Therefore, the further study will divide students into two groups (i.e., experimental and control groups). The students in the experimental group will asked to participate in a new proposed system, while those in the control group will continue to use traditional learning style. The collected data could be displayed what are differences of PHP programming skills and code comprehension between the two groups.
REFERENCES


