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Designing of LMS using in Flipped Classroom to Enhance Knowledge Transfer

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Abstract: Learning Management System (LMS) plays an important role in classroom. According to the increase of devices and connectivity, LMS becomes widely used in education institutes. The present study aims to purpose key elements and development process of the LMS usage in flipped classroom environment. System Development Life Cycle (SDLC) was used in the development phase while learning outcome was investigated in the evaluation phase. The target group of 22 students studied by using the LMS and flipped learning including 5 learning processes: 1) Knowledge acquisition; 2) Knowledge transfer; 3) Knowledge construction; 4) Knowledge reflection; and 5) Knowledge sharing. The results revealed that key elements of LMS composed of 5 elements: 1) Problem base and Learning task; 2) Knowledge Bank; 3) Scaffolding; 4) Collaboration; and 5) Coaching. The LMS was designed in Model-View-Controller (MVC) structure with Yii2 framework. It showed the relationship of retention and transfer test was positive (r = 0.569) and learning outcome of most students was constructivist learning (59.09%). However, no learning and rote learning were found among the students of 22.73% and 18.18% respectively. The guidelines for developer and the LMS can be used in the classroom are provided in this paper.

Keywords: Learning Management System, Flipped Classroom, Knowledge Transfer, Learning Outcome

1. Introduction

In this century, students are not only able to remember things but also able to transfer their knowledge to accomplish the tasks. Constructivist learning is a kind of learning outcome that students can both recall prior knowledge and transfer to appropriate problem (Mayer, 1996). From this perspective, retention and transfer skill are important. Flipped classroom is the pedagogy approach that focuses on learner-centered and widely used in the recent years. The concept of flipped classroom has been traditionally done during the class i.e. lecture is shifted to home activities such as homework and projects transferred to class activities (Sohrabi and Iraj, 2016). Therefore, knowledge transfer is essential to accomplish the learning objectives. Learning management system (LMS) is important to bridge this gap. It is not just resource repository but also to support learning process as well. There are advantages of web technologies such as geographically independent so that the student can study in their own time and place. It means they can control their learning process. This might encourage student learning motivation. When the class begins, they are ready to do activity more attentively. Specific purpose of LMS is needed to address this issue. This study aims to design the process of LMS using in flipped classroom to enhance knowledge transfer and investigate learning outcome among the students.

2. Literature review

Learning Management System (LMS)

Learning Management System (LMS) is the software for learning management. LMS is often used to deliver material, learning process management and support communication among learners and teachers (Bele, Mujkić, Bele and Mujačić, 2015). Student can search information or test. Nowadays, LMS is a form as web application and advantage of online learning. LMS can overcome geographically issue because student can learn at their own time and space. LMS consists of many technologies such as blog, wiki, discussion board or digital learning material. (Kaewkiriya, Utakrit and Tsuji, 2011; Partheeban and SankarRam, 2014). In previous study, Swart (2016) purposed the components of LMS into four sections: 1) Contents, 2) Assessment, 3) Communication and 4) Administration.

Flipped Classroom

Flipped Classroom is another kind of blended learning which has face-to-face (F2F) learning and online learning. Most activities in the traditional classes were inverted. Students perform knowledge acquisition (preparation) at home by watching video or another material and then perform activity in class. The term of flipped classroom originally came from teachers Jonathan Bergmann and Aaron Sams in 2007 (Sohrabi and Iraj, 2016). It was created to help absent students keep up with their classmate by using recorded video. By this method, mass learning group is accessible via using internet technology. Salman Khan invented Khan Academy and shared his thought at TED talk at the time he helped his cousin to understand the lesson by recorded videos. Nowadays, Khan Academy becomes global resources for people around the world (Khan, 2011). There is no official model for flipped learning. In this study, flipped learning is adapted from Kanjug's model (2014) and will describe in the next section.

Knowledge Transfer

Knowledge transfer is a form of knowledge acquired from one task or situation. It can be applied to different task (Nokes, 2009). Flipped learning students need to transfer knowledge outside the class into the class. We interest in the knowledge transfer mechanism purposed by Gentner, Holyoak and Kokinov, 2001; Nokes, 2009). It is "analogical transfer" which composed of three processes: 1) retrieve prior knowledge 2) creating a mapping with new context and 3) transfer to new context. We could use this concept to create learning task to support knowledge transfer.

Learning Outcome

There are two major goals of learning: remembering and understanding. Remembering is the ability to recognize the lesson learned which can be measured by retention test. Understanding is the ability to construct relevant knowledge to use in new situation which can be measured by transfer test. Learning outcome can be categorized into three groups: constructivist learning, rote learning and no learning. The difference of rote learning and constructivist learning depends on retention and transfer ability. Constructivist learners perform well at both of retention and transfer test whereas rote learner perform well at retention but poorly at transfer test. In addition, no learning means they fail in both at retention and transfer test. The concept learning outcome can be summarized in Table 1 (Mayer, 2001).

Table 1: Learning outcome.

Learning Outcome	Retention Test	Transfer Test
Constructivist learning	Passed	Passed
Rote learning	Passed	Failed
No learning	Failed	Failed

3. Method

System Development Life Cycle (SDLC) was used in development phase. The LMS was used with target group of 22 students in high school. The context was computer classroom with computer program subject. Learning outcome were derived from transfer and retention test. Correlation between transfer and retention test were investigated by using Pearson's correlation. In the following section, the details about development process will be described.

Preliminary Investigation

We purposed the framework design as shown in Figure 1. It consisted with 5 stages of learning outside the classroom activity and during class learning activity. From these learning processes, we form the elements of LMS which are essential to use in each process; 1) Problem base and learning task; 2) Knowledge bank; 3) Scaffolding 4) Collaboration and 5) Coaching. The description of each key element is shown in Table 2.

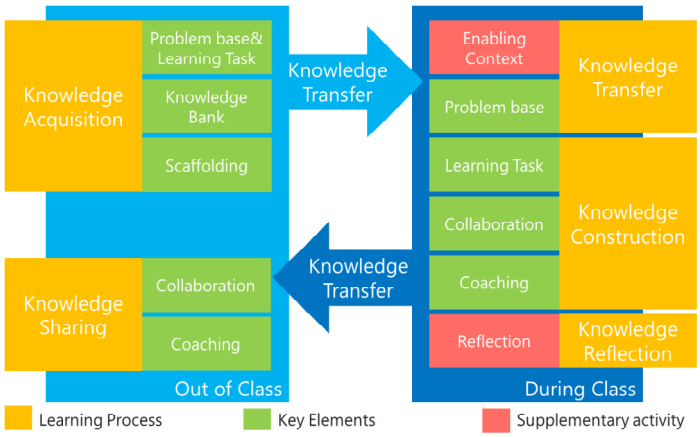

Figure 1. Framework Design.

Figure 1 illustrates framework design. There are 5 stages of learning process which are separated into 2 stages outside classroom activity and 3 stages during class activity. Students begin to perform knowledge acquisition by studying problem base and learning task. Knowledge bank and Scaffolding are provided to support students. After finishing individual preparations, they share their knowledge by using collaboration tool (in this study we use web board). Teacher provides feedback and facilitates students by observing learning activity. At the same time, other students learn from multiple perspectives from their classmates. During the class, students transfer their knowledge to perform activity. Outside classroom task and during class activity was shared common knowledge. This leads students to transfer their prior knowledge into new situation or problem solving. Enabling context and reflection are supplement activities when students are lack of attention or confuse with the lesson they learned.

Table 2: The key elements and descriptions of purpose LMS.

Key Elements	Description
Problem base & Learning Task	Authentic problems with meaningful tasks
Knowledge Bank	Knowledge repository for student to accomplish their goals
Scaffolding	Scaffolding composes of 4 types: conceptual scaffolding, metacognitive scaffolding, strategic scaffolding and procedural scaffolding
Collaboration	Place for collaborative learning and sharing.
Coaching	Teacher provide supports to help the student perform a task

System Analysis

We collected user requirement and then described as the use case diagram. The LMS has 2 types of user (actor) refer to Student and *Teacher*. Their functions to the system are shown in Figure 2.

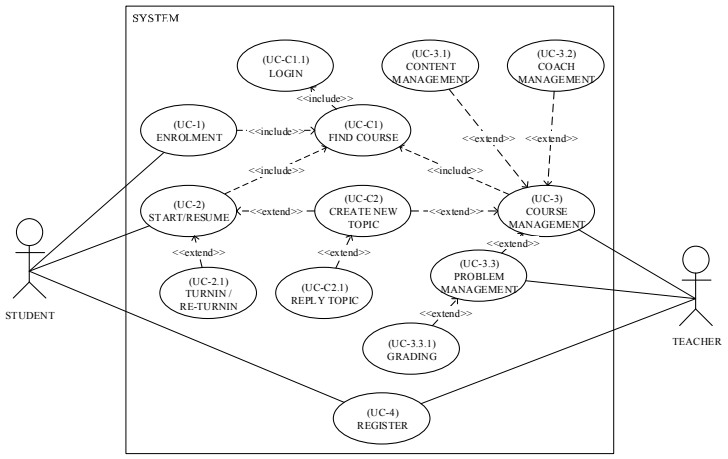

Figure 2. Use case diagram.

Teacher: The main function, teacher is responsible to create, update or delete the course. All information of the course such as course descriptions, problems of the tasks, scaffoldings, and coach information can be modified. Assignment can be added after the course has created. The LMS enable teacher to assign course work and due date as well as evaluation of student assignment.

Student: Student is responsible to enroll the course. After enrolling the course, students search for information provided and perform the learning task. Students submit the assignment. When the assignment is evaluated, student can get feedbacks and scores. They can choose to submit the assignment again and the submission history will be recorded.

The teacher and students can share problems or ideas by user registration or web board.

System Design

Yii2 framework was used to develop LMS. Yii2 framework is well known for developer. MVC (Model-View-Controller) structure is an application developed by Yii2 framework. The other advantage of Yii2 framework is the tool for coding generation; Gii. Developer do not need to code for CURD (Create, Read, Update, Delete) operation from the beginning, so Gii can reduces development time. The detail of MVC, data modeling and process are described as following.

Model-View-Controller Application Structure

The LMS was designed in MVC structure which separates the whole system into three sub-modules: Model, View and Controller.

Model is responsible to manage. It is lower module that closes to database. The important role of *Model* is to validate data and perform CRUD operation of database as well as manage relation between tables in database.

View is responsible to generate all the information in the web page (User Interface). Generally, the system renders information to the web browser bases on HTML (Hypertext Markup Language), JavaScript and CSS (Cascading Style Sheet).

Controller is responsible to perform logical part of system such as calculation, data filtering and selecting, route control etc.

Process and Data Flow of the LMS

The LMS data model and process by using data flow diagram as shown in Figure 3. In brief detail, we explore each process as follow. All registered users are managed by *User Management* which handles task of signing up. The data of new users will be stored in *User* table. Similarity with function of user is described by case diagram. Teacher has ability to create the course and update appropriate activity course information. This task is performed by *Course Management* which directly updates data in *Course* table. After course has created, students can enroll the course handled *Enrolment System*. All of enrolment transactions are recorded in *Enrolment* table. Student can submit their assignment via *Course Work Management* and teacher can evaluate student submission via *Grading System.* During learning activity, student and teacher can post or reply about the topic on web board. This task is handled by *Web Board Management.*

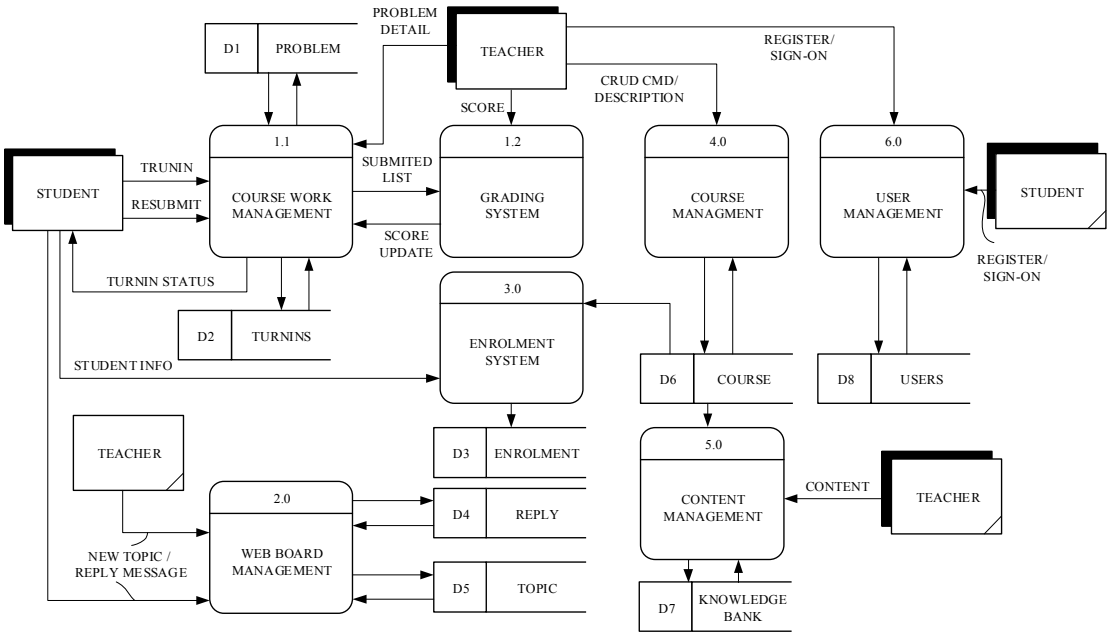

Figure 3. Illustration of data flow diagram.

System Development

The LMS was implemented by using Yii2 framework. Basically, Yii2 framework is PHP framework provided for developer to build systematic of MVC structure application. Developer requires the knowledge of object-oriented programming and the knowledge of web technology such as HTML, CSS and JavaScript. We found that Yii2 framework reduced the development time because of the MVC architecture of Yii2 framework is suitable for web application development. Another advantage of using Yii2 framework is the tool for auto-generated code called Gii for CRUD operation of data in database. Developer does not need to code everything from scratch because this tool provides the automation of code generation. Some of user interfaces are shown in Figure 4 – 8.

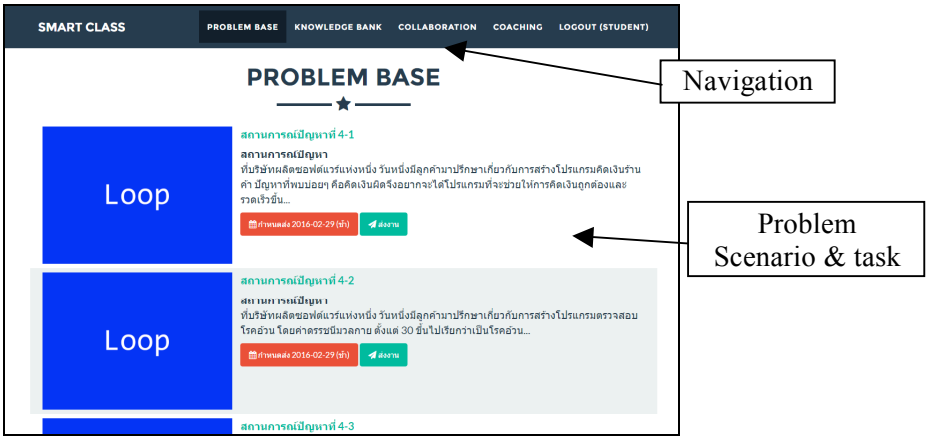

Figure 4. an illustration of class main page.

Figure 4 displays the class main page. There is navigation bar at the top which is the key element of the LMS: Problem base, Knowledge Bank, Collaboration and Coaching. Problem base consists of problem scenario and task.

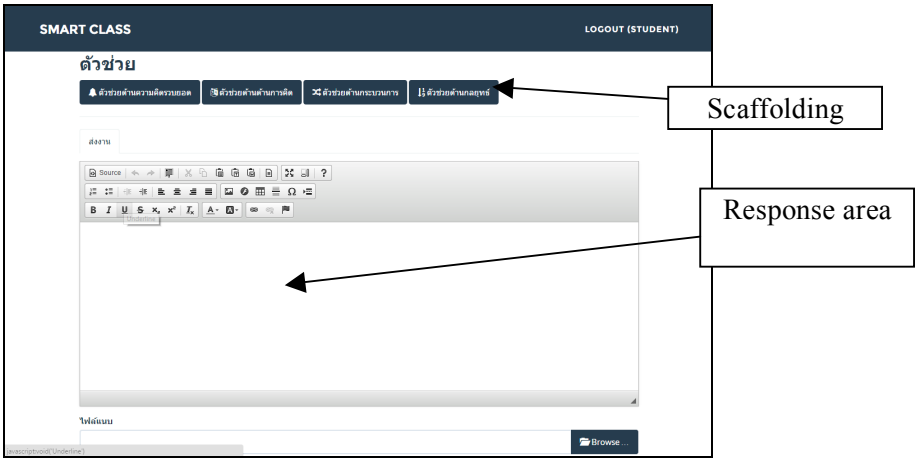

Figure 5. An illustration of assignment submission page.

Figure 5 illustrates assignment submission page. Students are provided scaffolding included conceptual scaffolding, strategic scaffolding, procedural scaffolding and metacognitive scaffolding. Texts, images and file can be added in the submission area. Students can submit several times. Each submission will be recorded by the system. The latest submission will be displayed first in the teacher's evaluation page. However, students and teacher can view submission history.

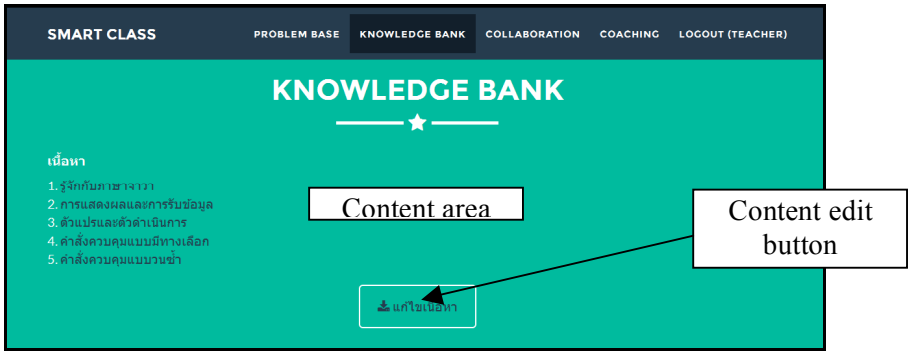

Figure 6. An illustration of knowledge bank

Figure 6 shows the knowledge bank page. Knowledge bank contains essential need for problem solving in the task. Contents include texts, images and video which are added by teacher.

Figure 7. An illustration of collaboration (web board)

Figure 7 demonstrates collaboration page. Web board is used to post any topics or share the information among students. Teacher can observe learning activity from web board and give student feedback.

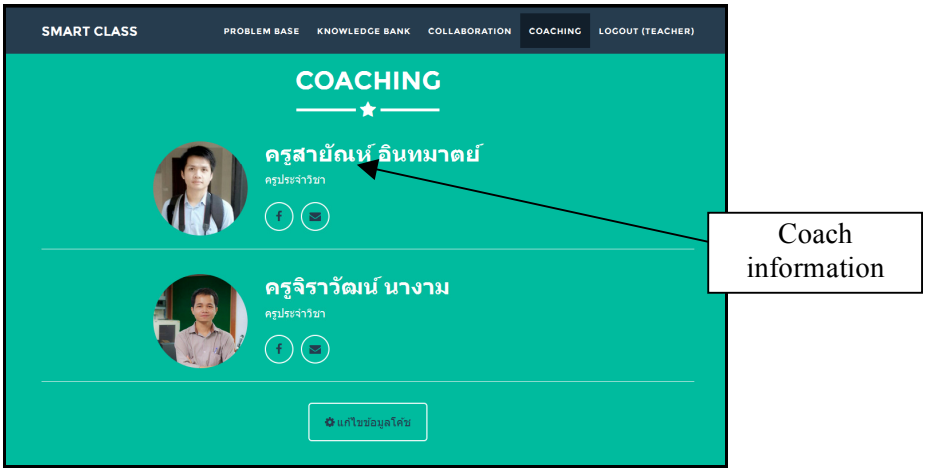

Figure 8. An illustration of coaching

Figure 8 explains coaching page. Coaching contains the information such as Facebook and e-mail of teacher or expert in the field. In this page, teacher can modify the course after it has created.

System Implementation

The LMS was installed in shared-host environment as shown in Figure 9. The system requirement of the host must meet Yii2 requirement. In this study, we installed in the system on the host with specification in Table 3.

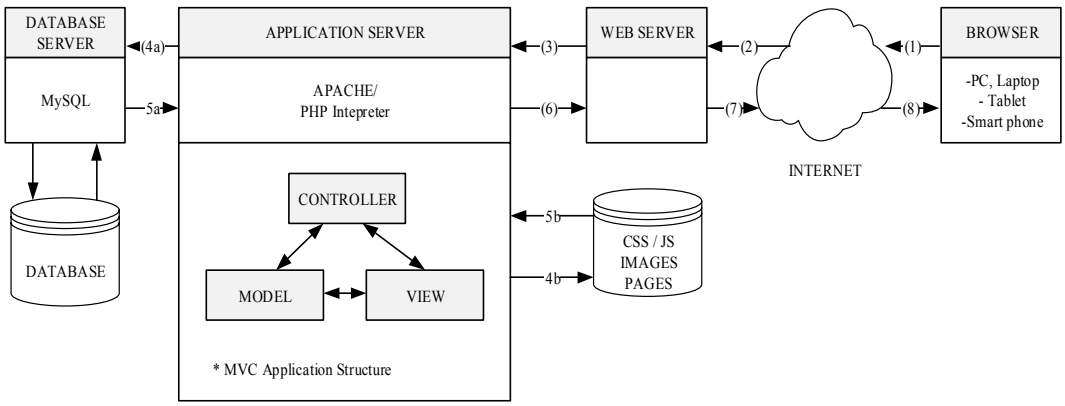

Figure 9. System environment.

Table 3: Testing environment.

Software	Description
Operating system	Windows 10 Education
Web server software	Apache 2.4.9
PHP version	5.5.12
Database management system	MySQL 5.6.17

4. Results and Discussions

The LMS was evaluated by experts and piloted with 22 students; 18 years olds in average. The study field was Pathumthep Wittayakarn School. Secondary school located at Nong Khai province, Northeastern part of Thailand. The study held during second semester, academic year 2015 (February – March, 2016) in context of computer classroom. Learning objectives were to help students know basic concept of computer programming such as input statement, output statement, data types and variable, decision making and loop in JAVA language. Lesson plans were designed based on flipped learning process (Kanjug, 2014). Learning tasks were designed to support knowledge transfer (Gentner et al., 2001). Experimental period was 6 weeks by using flipped learning. Achievement test and transfer examination were tested in the week 6, retention test was 2 weeks later. The result of the test was shown in Table 4.

Table 4: Test score of target group.

	Achievement Test, M (S.D.)	Retention Test, M (S.D.)	Transfer Test, M (S.D.)
Target Group	6.82 (1.18)	5.09 (1.41)	10.64 (3.19)

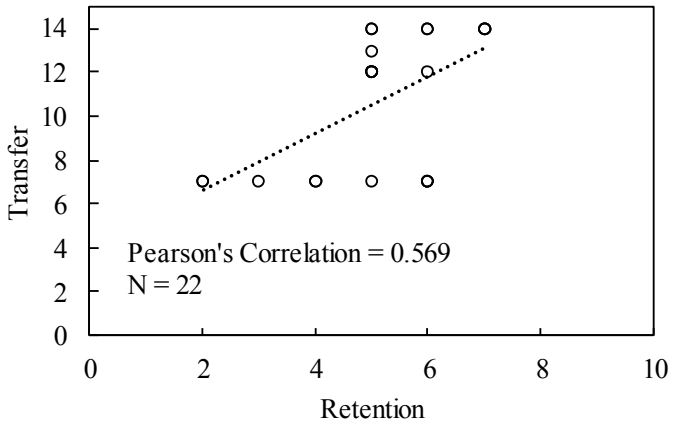

Figure 10. Correlation between Retention and Transfer Test.

In Table 4, Achievment test score of target group was 6.82 (SD = 1.18) and retention test score was 5.09 (SD = 1.41), roughly reduced 25% after achievment test 2 weeks. Transfer test score was 10.64 (SD = 3.19). The standard deviation was quite high means. There was different transfer ability among the target group. In Figure 10, we found the correlation between transfer test and retention test was positive (r = 0.569), transfer score propotionally increased when retention score increased and vice versa. By using criteria half of maximum score, we could get student who passed the test. Learning outcome is demonstrated in Table 5.

Table 5: Learning outcome of target group.

	Frequency	Percentage
Constructivist learning	13	59.09
Rote learning	4	18.18
No learning	5	22.73
Total	22	100.00

Learning outcome of students is shown in Table 5. We found more than half of learning outcome of students was constructivist learning at 59.09% whereas no learning at 22.73% and rote learning at 18.18%. The result revealed the efficiency of learning by using flipped classroom with purposed LMS could enhance students to perform constructivist learning more than half of class. Constructivist learners could transfer their learning into relevant situation. They performed well at retention and transfer test. However, there were several students at rote learning and no learning point. For those rote learning students, they failed transfer test. For no learning students, they failed neither retention test nor transfer test. The continuity of learning may affect testing result due to the target group were grade 12 students who were busy and worried about admission to university in the following year as shown in Figure 11. There were many tasks to concern and manage, this may also affect to the learning outcome.

(a) (b)

Figure 11. (a) and (b) Illustration of target group was using the LMS

5. Conclusion

In this paper, we purposed the key elements of LMS to use in Flipped Classroom as well as development process. Yii2 framework was used to build MVC application. The advantage of using Yii2 framework was the reduction of development time and effort. The value of this study, LMS was approved by experts and constructivist learning was made most among the target group. For future study, we plan to improve the LMS functionality and develop mobile application.

Acknowledgements

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References

Bele, J. L., Mujkić, S., Bele, D., & Mujačić, S. (2015). User and mobile-friendly learning management system design. In *2015 XXV International Conference on Information, Communication and Automation Technologies (ICAT)*, 1–6.

Gentner, D., Holyoak, K., & Kokinov, B. (2001). *The Analogical Mind: Perspectives from Cognitive Science*. Cambridge: The MIT Press.

Kaewkiriya, T., Utakrit, N., & Tsuji, H. (2011). Experimental evaluation of distributed e-Learning management system. In *TENCON 2011 - 2011 IEEE Region 10 Conference,* 1193–1197.

Kanjug, I. (2014). *Innovation and Information Technology for Learning in Faculty of Education*. Khon Kaen, Thailand: Khon Kaen University.

Khan, S. (2011). *Let's use video to reinvent education*. Retrieved from https://www.ted.com/talks/salman_khan_let_s_use_video_to_reinvent_education?language=en

Mayer, R. E. (1996). *Design Instruction for Constructivist Learning. Instructional Design Theories and Models: A New Paradigm of Instructional Theory* Volume II. New Jersey: Lawrence Erlbaum Associates.

Mayer, R. E. (2001). *Multimedia learning*. New York: Cambridge University Press.

Nokes, T. J. (2009). Mechanisms of knowledge transfer. *Thinking & Reasoning*, *15*(1), 1–36.

Partheeban, N., & SankarRam, N. (2014). e-Learning management system using web services. In *2014 International Conference on Information Communication and Embedded Systems (ICICES),* 1–7.

Sohrabi, B., & Iraj, H. (2016). Implementing flipped classroom using digital media: A comparison of two demographically different groups perceptions. *Computers in Human Behavior*, *60*(July), 514–524.

Swart, A. J. (2016). The effective use of a learning management system still promotes student engagement! In *2016 IEEE Global Engineering Education Conference (EDUCON)*, 40–44.