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Design and Development of Interactive Moodle-Based E-Learning Platform for Competency Training †

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Abstract: During the COVID-19 pandemic, the global education system changed its context of instruction to be online. Teachers need to interact with students in learning management systems (LMSs) to overcome the limitation of instruction during the pandemic. To promote interactive online learning with LMSs, moodle-based e-learning is proposed in this study. In the e-learning system, the instructional design was proposed using the integration of Moodle and the H5P engine. A six-step inquiry learning approach was included in the design as an effective solution for using online platforms.

Keywords: online platform; interactive learning; competency training

1. Introduction

The COVID-19 pandemic disrupted the global education system and changed the context of students' learning styles. Normally, most students were educated in a learning environment at school, but now the COVID-19 pandemic has changed it to online learning or e-learning environments. Therefore, the learning management system (LMS) has become necessary to support teachers on online learning platforms to change teaching and learning mechanisms. Therefore, designing and developing an interactive Moodle-based e-learning platform to support students' learning with LMS is necessary. Through this study, we provided a solution for various organizational challenges to improve the learning platform effectiveness of regular classes based on human-centered design (HCD) and LMS. The solution offers students self-regulated learning (SRL) via scientific inquiry in the six-step model on the Moodle platform, affecting students' development in reasoning. Integrating the six-step scientific inquiry and interactive Moodle-based e-learning platform improves the student's scientific explanation ability on the engine-driven online learning platform.

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2. Literature Review

2.1. LMS

LMS is a technology platform that allows distance and flexible learning through e-education with software and supports virtual academic activities without location and time limitations [1]. Habits and social pressure affect people's use of LMSs [2]. Students and teachers depend on the LMS in online education as all course materials and assignments are sent through its platform in the learning process. E-learning platforms like Moodle are one type of LMS. The main idea is to change the human-made learning mechanism on site into an engine-driven online learning mode with H5P, Phet interactive simulation, and online resources.

2.2. HCD

HCD is a set of techniques to invent innovative solutions for various societal challenges, including goods, services, spaces, institutions, and methods of communication [3]. HCD is used in engineering design for students to understand and practice the way of the engineering design process and techniques to solve open-ended engineering problems [4]. The model is used to identify the open-ended problem with the scope of ideas and concepts to select the prototype. After building the prototype, it is used in the experiment to check the constraints. In HCD, a suitable method to improve the learning platform can be found to support teaching and learning.

2.3. Self-Regulated Learning (SRL)

SRL effectively promotes students' motivation to learn, reflects on their learning, and improves their understanding of subjects [5,6]. By engaging in self-regulated learning, students are better equipped to comprehend challenging topics in-depth during the learning process [7]. Research about flipped classroom integrated SRL revealed that students who adopted the self-regulated flipped classroom approach demonstrate improved performance in goal setting, strategy planning, time management, seeking assistance, and self-regulation [8]. Thus, we designed an e-learning platform to promote SRL to drive students to engage and be active in learning.

3. Design and Development

3.1. Human-Made Learning to Engine-Driven Online Learning

A prototype of the engine-driven online learning platform was developed in this study to improve the student's competencies by incorporating MS in regular classrooms. Previously, teachers' pedagogies depended on their classroom context. They gave normal instruction with their instructional media in classrooms. Normally, the teacher directs scientific content, scientific activity, experiments, and data summaries for students to learn. As shown in Figure 1, human-made learning starts with content-related videos to motivate the student. After the video, the teacher asks questions to the student. The student takes a few minutes to think about their answers before the activity. To find the questions, the teacher sets equipment or information to guide the student to find the answer. When the student completes the activity or experiment, the teacher starts to explain and conclude the lesson. Even though this technique provides students with understanding, all processes are offered and led only by the teacher. The student receives information rather than discovers it. Therefore, the upgraded method is necessary to change the learning mechanism.

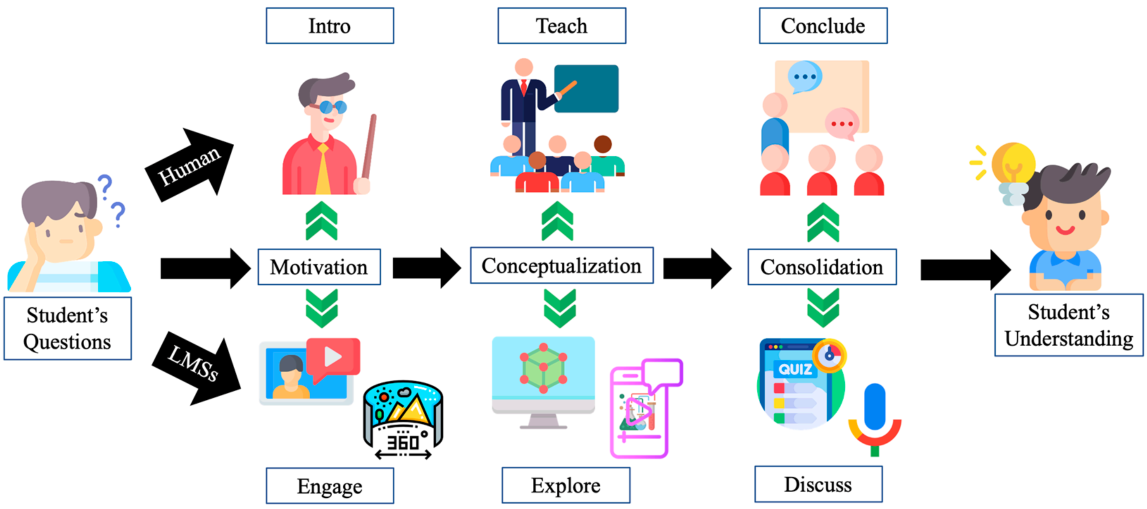

Figure 1. The comparison of the human-made learning mechanism with the LMSs moodle-based e-learning platform with the MC^2 model.

LMS is implemented to assist students' online learning in classrooms with a focus on an interactive Moodle-based e-learning platform combined with the pedagogies known as MC^2. In LMS, students are motivated and are engaging in learning with curiosity to find questions to ask. Conceptualization is the process to explore and discover a shred of evidence, and consolidation is the stage of conclusion and discussion through the student's communication to find reasoning. In the Moodle-based e-learning platform, MC^2 is used to conduct a scientific inquiry process with 6 steps to develop students' competencies. The first step is a scientific investigation to define the circumstance. Step 2 is the inquiry question to find the background knowledge in the third step. Developing conceptualized content and data analysis is carried out in the fourth step. Step 5 is for the analysis of the results, followed by step 6 to conclude. Such a process allows students to learn independently as personalized learning and be motivated. Then, SRL is realized in the student's online learning process.

3.2. Interactive Moodle-Based E-Learning Platform

In the six steps of scientific inquiry, we looked for the proper H5P hub, H5P-specific plugins, and web applications such as the Phet interactive simulation for each sequence on the Moodle platform. In interactive videos, we offer a virtual 360° tour and picture hotspots, course presentation, scientific interactive video or scientific simulation, quiz or set of questions, and audio records. The first phase of scientific inquiry is to build an interactive movie with motivating questions to engage students in the event. An interactive video may lack content knowledge of the solution for the inquiry. As shown in Figure 2A, 3 to 5 sub-questions with multiple interactions are asked to attract the student's attention.

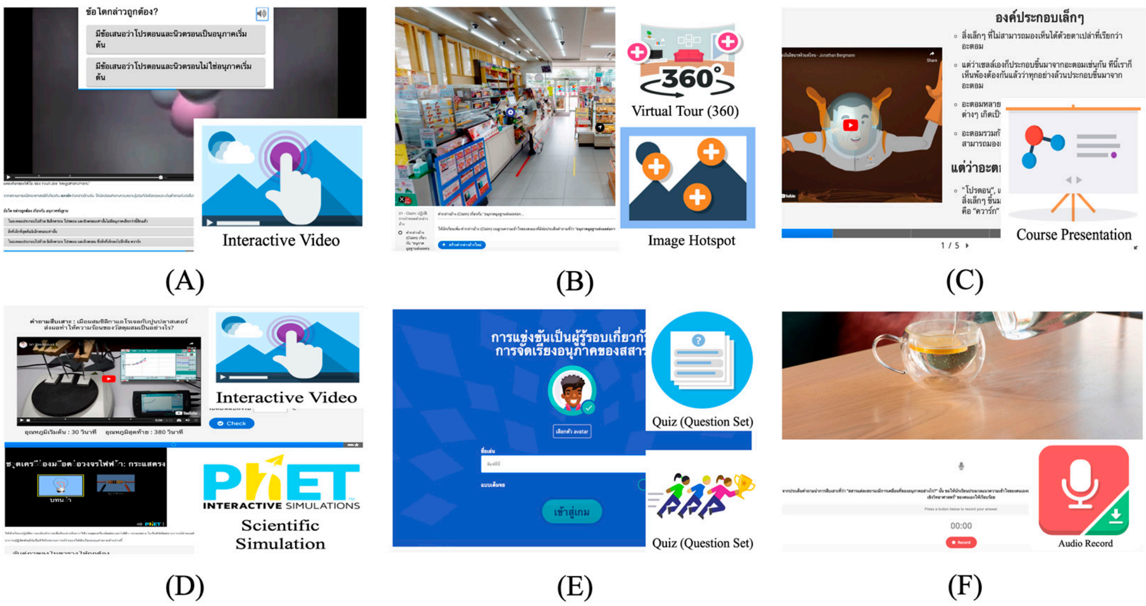

Figure 2. The sequence of six-step scientific inquiry with the platform: (**A**) presenting learning scenario using interactive video, (**B**) discovering essential inquiry question in virtual tour 360°, (**C**) providing related scientific information in a multimedia presentation, (**D**) interacting content-specific learning materials and analyzing obtained primary data, (**E**) sharing and monitoring the results, and (**F**) producing a scientific explanation-based conclusion.

The goal of the inquiry question was asked during an interactive virtual tour to conceal the inquiry question within the image. To create the virtual tour and picture hotspots, we must provide a proper setting for the knowledge point. On student devices, the virtual tour of the environment outside of the classroom was displayed. They explored the area and found the inquiry question to move to the next phase as shown in Figure 2B. To understand background information, the interactive course presentation is provided to recheck the student's understanding of the material. In the presentation and the video, scientific contents are given with caution not to provide a solution to an inquiry question. A scientific foundation is required to comprehend the material and present their investigation. These activities are streamlined as shown in Figure 2C.

Depending on the topic, two types of interactions occur in scientific simulation and interactive science experiments. The student must pay attention to the procedure to find answers to the inquiry question and conduct data analysis. In the simulation, we integrate the interactive simulation from Phet, the University of Colorado Boulder, which contains simulations with scientific and mathematical contents. The simulation's parameter can be changed to represent the scientific phenomena at microscopic and macroscopic scales for observation and data collection. The interactive scientific experimental video gives authentic laboratory experiments. Variables are found in each experiment, and data are collected to explain macroscopic-level phenomena. It prompts a subquestion to encourage them to concentrate on the process. In this step, we interactively assess the student's performance in H5P using fill-in-the-blank, multiple-choice, and drag-and-drop questions. This assessment is to evaluate the collected data and information interactively as shown in Figure 2D. The investigation results of the student are assessed through quizzes or questions to find out the level of the student's understanding. The quiz is given to provide various questions in various formats such as multiple choice, drag and drop, and fill-in-the-blanks. In addition, the questions in a quiz set are made for students to challenge and communicate with their peers. When the student has misconceptions, the teacher interrupts and corrects them as shown in Figure 2E. The teacher's role is emphasized more than in other steps. Finally, the student's audio records are made in the conclusion stage as shown in Figure 2F. The student explains the question, evidence, and reasoning from their learning and concludes their knowledge.

4. Conclusions

The design of online instruction on LMS, Moodle, and the H5P engine was developed to overcome the teaching and learning limitations. We combined the MC^2 and the interactive Moodle-based e-learning platform in online learning. The online learning platform was designed to improve students' competencies in a six-step process. (1) Based on the circumstances, an interactive film with questions is created to motivate the student. (2) The inquiry question is found in an interactive virtual tour or interactive image, and (3) the theoretical background and information are given in an interactive presentation with questions to check the student's comprehension. (4) Content and data analysis are performed in the scientific simulation and interactive experimental video. This stage requires the student to pay attention to the evidence of the answers to the question through data analysis. (5) The results are given in quizzes or questions to test the student's comprehension. (6) The conclusion is made by the student who explains evidence and reasoning. This scientific inquiry approach and interactive Moodle-based e-learning platform enhance the students' learning online.

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