Model IoT-Knowledge-Based Flipped Classroom for Smart Web Programming Learning

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Abstract. Incorporating Internet of Things (IoT) technology in education has significantly changed traditional learning approaches. The flipped classroom model has shown great potential in the context of learning Smart Web programming. However, there are challenges in optimizing this type of learning, such as the need for in-depth knowledge of Smart Web programming. Therefore, we propose an IoT-Knowledge-Based Flipped Classroom Model to enhance Smart Web programming learning. This research aims to develop a learning system design model that is devoted to being a guide in designing learning for Smart Web Programming courses using the Flipped Classroom method based on Knowledge Management and IoT. This research uses formative research methods by collecting the necessary descriptive and formative data. Formative evaluation includes expert tests, one-on-one evaluations, and field tests. This research will be attended by seven learning design and learning experts and peer lecturers. This model is expected to be in accordance with the Flipped Classroom learning conceptual framework, is feasible, and can be implemented as a model in designing learning for Smart Web Programming courses with the Flipped Classroom model based on Knowledge Management and IoT.

Keywords: programming learning, smart web, flipped classroom, knowledge base learning, Internet of Things.

1 Introduction

Based on data from the Central Statistics Agency for 2022 [1], 884,769 openly unemployed people have graduated or graduated from universities. So, improvements are needed in the learning curriculum in tertiary institutions. Currently, universities are required to apply the IQF (Indonesian National Qualifications Framework) as stipulated in Presidential Regulation Number 8 of 2012 and Higher Education Law Number 12 of 2012, as well as Minister of Education and Culture Regulation Number 73 of 2013. The implication of implementing the IQF in tertiary institutions is a change in the learning paradigm from Teacher Centered Learning (TCL), where learning is teacher-centered, to Student-Centered Learning (SCL), whose learning system is stu-

M. Salimi et al. (eds.), *Proceedings of the 7th International Conference on Learning Innovation and Quality Education (ICLIQE 2023)*, Advances in Social Science, Education and Humanities Research 873,
https://doi.org/10.2991/978-2-38476-301-6_73

dent-centered. In addition, there are problems in the Smart Web Programming course; there are problems with limited study time and poor processing of teaching materials, so the impact on learning outcomes could be more optimal.

Changing the learning approach from TCL to SCL requires a student-based learning model. One learning model that can apply SCL is the Flipped Classroom model. As written in the 2014 NMC Horizon Reports, the Flipped Classroom is a learning model that will be adopted in future teaching and learning. Flipped Classroom can improve student achievement, increase student motivation, and provide more time in class for educators and students to ask high-level questions and receive immediate feedback [2].

In implementing Flipped Classroom, there is a phase where students study independently before learning is carried out in face-to-face classes. Students learn independently at home regarding material for the next meeting by studying teaching materials given by the lecturer at the end of the lesson. Therefore, it is necessary to manage the material or teaching materials in the form of learning module files and practicums accompanied by explanatory videos of these teaching materials.

Management of knowledge or knowledge is intended to make it easier for each student to complete the project that is the task of each group, and there is an application feature to distribute all the results of group assignments to all students in the class they take part in. The Knowledge Management System can be integrated with the LMS (Learning Management System), which applies the Flipped Classroom learning method to manage teaching material files and learning videos by the RPS (Semester Learning Plan).

In implementing LMS Flipped Classroom, monitoring of the security of access to teaching materials is needed, where users who will access these teaching materials must match the class participants registered in the available course schedule. According to Mike Thomas on the builtin.com site, there are several examples of implementing IoT (Internet of Things) in education: IoT for interactive learning, IoT for reading and scanning documents, and IoT for STEM (Science, Technology, Engineering) learning. , and Mathematics), and IoT for secure connectivity. Therefore, in this study, the authors will adopt IoT to improve LMS security to avoid accessing the system by unauthorized persons or not by the class being attended in the current semester. In addition, IoT devices will also be used to carry out Peer Assessments, which are assessments of group work results by fellow students.

Several studies state that Flipped Classroom is effective for improving learning outcomes [3], [4]. According to Kardipah & Wibawa [5], the Flipped-Blended learning model with Augmented Problem Based Learning can also improve students' computer skills. Research on the adoption of the Internet of Things (IoT) in education can help build smart campuses [4], [6], [7], [8]. In 2018 Tarus, John K. Niu, Zhendong Mustafa, Ghulam [9] conducted research on Knowledge-Based Learning to improve learning outcomes in e-learning systems. There is research that integrates the Flipped Class-room learning model with IoT devices, but no one has simultaneously implemented Knowledge-Based Learning in managing teaching materials that will be accessed by students in the online learning phase. For this reason, researchers will develop a Flipped Classroom learning model that is implemented in a Learning Man-

agement System (LMS) system that is integrated with Knowledge-Based Learning and applies Internet of Things (IoT) technology to ensure users who access the LMS are students enrolled in classes that scheduled.

1.1 Research Objectives

This research has the following objectives: 1) produce a Flipped Classroom learning design based on Knowledge-Based Learning and Internet of Things (IoT) that is suitable for learning Smart Web Programming; 2) produce a Knowledge-Based Learning and Internet of Things (IoT) based Learning Management System (LMS) application product for learning Smart Web Programming; and 3) Analyze the feasibility and effectiveness of learning the IoT Knowledge-Based Flipped Classroom model for learning Smart Web Programming.

1.2 Novelty of the Research

So far, many have conducted research on the Flipped Classroom learning model that has been published, but so far, no research has been found on the Flipped Classroom learning model that manages teaching materials by integrating the Knowledge Management System (KMS) into the Learning Management System (LMS) system. Likewise, with the Internet of Things (IoT) technology, which is developing quite rapidly, no one has yet adopted IoT technology to be integrated with the Flipped Classroom learning model which is also Knowledge-Based Learning.

1.3 Flipped Classroom

Flipped Classroom implementation has been studied in several studies [5], [10]. This study will apply learning with the Flipped Classroom model which is a sub-model of Blended Learning. Learning with the Flipped Classroom model is implemented by asking students to rotate in a fixed schedule between face-to-face learning practices with other students during class hours and the delivery of learning material online outside of class hours. The media for delivering learning material is online, which in this study uses the Brisma LMS which is integrated with the management of teaching materials and increases the security of data access by implementing tokens that will be obtained through the Brisma IoT device.

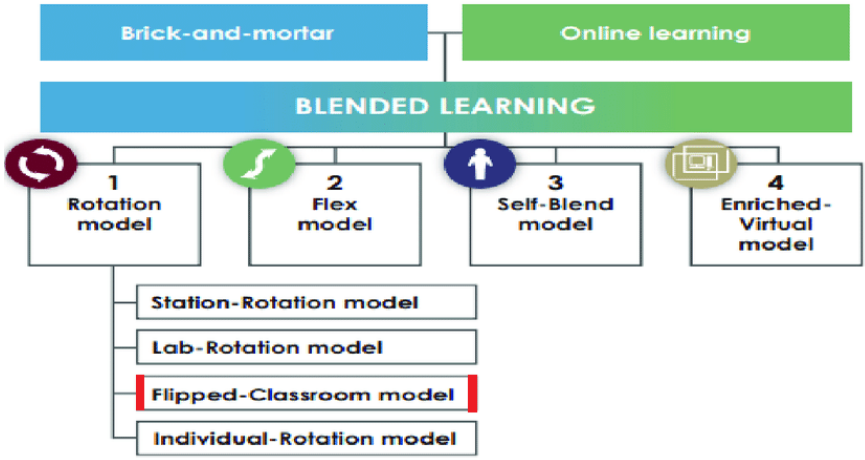

Fig. 1. Blended Learning Models (Horn & Staker, 2015 [11])

1.4 Knowledge-Based Learning

Knowledge-Based Learning is an approach to the learning process that emphasizes acquiring, organizing, and applying knowledge. This approach views knowledge as a dynamic resource which can be developed and enriched through the learning process. The concept of Knowledge-Based Learning emerged from the fields of cognitive psychology and learning theory. One theory related to Knowledge-Based Learning is the theory of constructivism, which emphasizes that learning involves building new knowledge based on previous knowledge [12].

The concept of Knowledge-Based Learning is the development of a Knowledge Management System, one of which is the SECI model. In 1995 Ikojiro Nonaka and Hirotaka created the SECI model [13], [14]. Knowledge can be grouped into two categories, namely Explicit Knowledge and Tacit Knowledge. Explicit knowledge can be interpreted as the result of tangible knowledge, for example, theses, final assignments, research reports, books, and the like. At the same time, Tacit Knowledge can be interpreted as knowledge that is still stored in the owner's head. Knowledge that is "invisible" because of its scattered and embedded existence in various forms, such as one's experiences, conversations between individuals, dialogues, formal and informal discussions, individual intelligence, decision-making mechanisms, thoughts, and so on . According to Nonaka Takeuchi, there are 4 models of knowledge creation that have been identified, namely socialization, externalization, internalization, and combination (SECI). Socialization is the process of converting tacit knowledge into new tacit knowledge, carried out by social interaction and various experiences between members of the organization. Externalization is the process of converting tacit knowledge into new explicit knowledge. Externalization is the process of converting tacit knowledge into new explicit knowledge. Internalization is the process of converting

explicit knowledge into new tacit knowledge. And Combination Creation of an explicit knowledge by merging, categorizing, reclassifying, and synthesizing existing explicit knowledge.

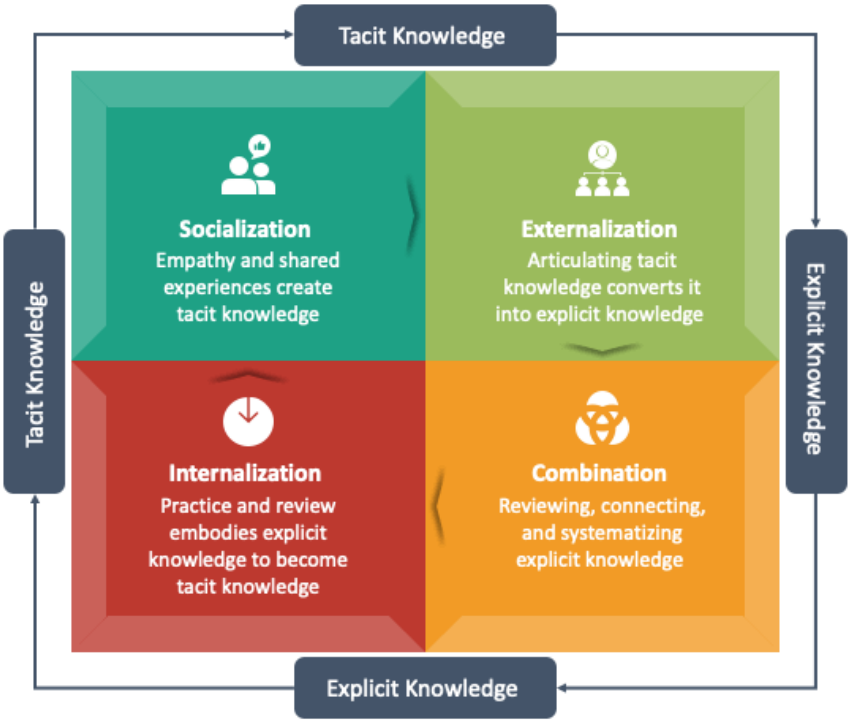

Fig. 2. SECI Model

2 Method

The model developed has the following characteristics: 1) Students involved in the development of the IoT-Knowledge Based Flipped Classroom model are students taking the Smart Web Programming course in the even semester of the 2022/2023 academic year, at the Faculty of Computer Science study program Informatics Engineering, University of Mercu Buana Jakarta; 2) Learning materials which usually use textbooks and are delivered as lecture materials with examples of Smart Web programs and case studies are changed to downloading textbook files and practicum module files as well as videos explaining learning materials as a reference for carrying out practicums; and 3) The learning method is carried out using the blended learning method which is a combination of synchronous and asynchronous learning through specially designed learning media using the Flipped Classroom method using the Brisma Learning Management System (LMS) application. This LMS application

is equipped with features to support the management of teaching materials with Knowledge-Based Learning and integrated with Brisma IoT devices. This learning delivery strategy is carried out by providing material asynchronously and followed by interactive learning activities (discussions, questions and answers, presentations) face-to-face which focuses on students where the lecturer acts as a facilitator and motivator. Learning materials provided synchronously allow students to do learning with a time that is adjusted to each individual, and the synchronous learning process strongly helps students to actively communicate and express opinions.

This research has a specific objective to produce a learning design model or commonly known as model development. Therefore the type of research that is relevant is formative research methods. Formative research is a type of research conducted before or during the process of developing or implementing a program, policy or initiative. The main goal of formative research is to provide an in-depth understanding of the context, needs, and characteristics of the target population or system that will be involved in the program or policy.

Formative research assists in gathering relevant data and information to understand the issues at hand, design appropriate approaches or strategies, and test prototypes or initial concepts before implementing them in full. This research aims to shape, formulate, and modify programs or policies that are being developed to suit the needs and expectations of users or stakeholders. The purpose of formative research is to improve three things as follows: 1) a particular case (product, event, or both); 2) a learning theory related to a particular case; and 3) descriptive theory related to learning theory. So it can be concluded that formative research is suitable for developing or improving something, one of which is learning theory. In other words, formative research is appropriate for developing a learning design model. In this case, the model to be developed is the Flipped Classroom learning system design model based on Knowledge Management and the Internet of Things (IoT).

3 Result and Discussion

Conceptual models are used to describe a more abstract understanding of a phenomenon or concept, which aids in thinking, analysis, and communication. The main purpose of the conceptual model is to simplify the complexity and visualize the relationships between the concepts involved in a system or domain. This allows one to better understand the structure and principles underlying a phenomenon or concept. Conceptual models can assist in understanding complex concepts, describe the relationships between the elements involved, and facilitate critical thinking and analysis. The use of conceptual models can provide a strong foundation in designing, managing, and solving problems in various fields.

According to Wibawa (2019) [15] the conceptual model is the embodiment of the conceptualization of the theories and principles behind the formation of Smart Web course learning with an LMS based on Flipped Classroom and Knowledge Based Learning which is also supported by Internet of Things (IoT) devices.). The conceptual model in this research is as shown below:

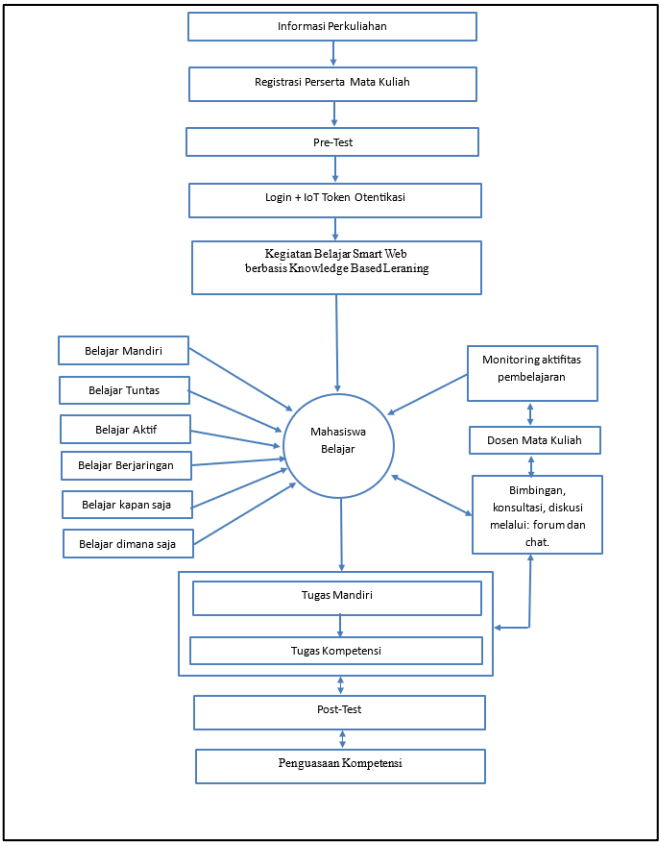

Fig. 3. Smart Web Learning Conceptual Model

The procedural model is an embodiment of the stages of forming Smart Web course learning with an LMS based on Flipped Classroom and Knowledge Based Learning which is also supported by Internet of Things (IoT) devices (Wibawa, 2019) [15]. The procedural model is a descriptive model that describes the flow or procedural steps that must be followed to produce a particular product. This model focuses on a series of actions or operations that must be carried out sequentially to achieve the goal or produce the desired output. In the context of product or system development, procedural models are used to describe how steps or procedures must be carried out to achieve the final result. This model includes details about the tasks to be performed, the order in which they are executed, the inputs required, and the outputs produced.

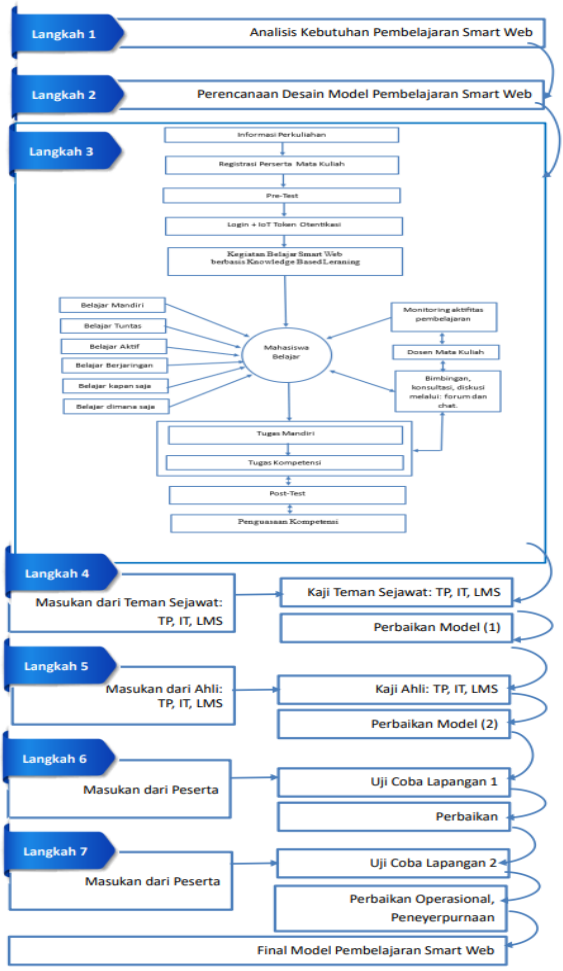

Fig. 4. Procedural Model

The physical research model refers to an approach or method that involves using physical objects or physical models to conduct research. In this model, physical objects are created or used as real representations of the phenomenon or system being studied. The use of this physical model helps in understanding, testing, or experimenting with certain concepts or theories. In using a physical research model, it is important to consider the limitations and research objectives to be achieved. Physical models can be used as valuable tools for initial exploration, validation of concepts, or deeper understanding of a particular system or phenomenon. According to Wibawa (2019) [15] the physical model is in the form of the physical form of Smart Web learning products with Flipped Classroom-based LMS and Knowledge Based Learning which are also supported by Internet of Things devices, which consist of 1) teaching materials in the form of pdf modules, presentation slides which can be download-

ed, learning videos, and quizzes and assignment files, and 2) lecturer and student guides, or operational steps in using the LMS IoT-Knowledge-Based Flipped Classroom application.

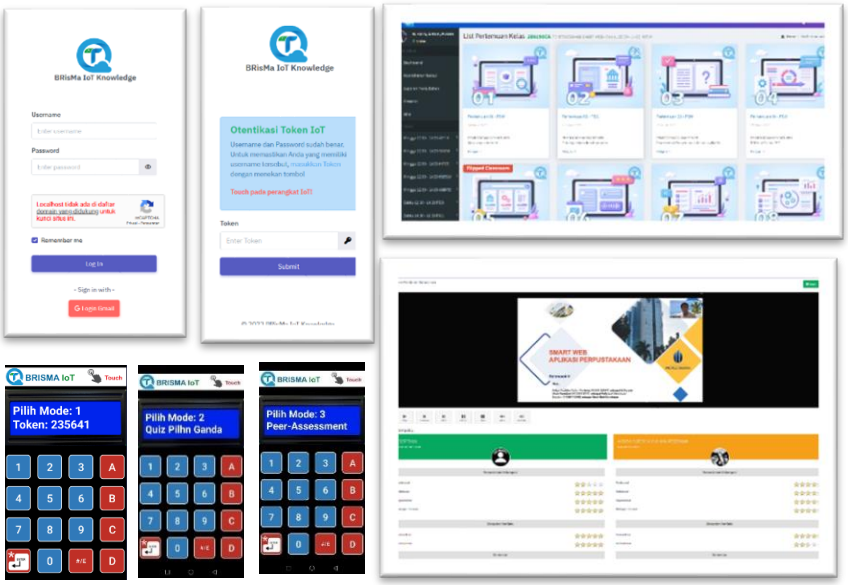

Fig. 5. Prototype Flipped Classroom on Brisma LMS and Brisma IoT Device

4 Conclusion

The proposed IoT-Knowledge-Based Flipped Classroom model is expected to improve the learning outcomes of Smart Web programming. This study uses a formative research method, which uses a series of formative evaluation techniques to collect the necessary descriptive and formative data. Formative evaluation includes expert tests, one-on-one evaluations, and field tests. This research will be attended by seven learning design and elearning experts as well as peer lecturers. After going through three stages of formative evaluation, namely the stage of making a tentative model, the feasibility of the model and the effectiveness of the model, this model is expected to be in accordance with the conceptual framework of Flipped Classroom learning, is feasible and can be implemented. So that it can be used as a model in designing learning for Smart Web Programming courses with the Flipped Classroom model based on Knowledge Management and IoT. The implementation of this model will use Brisma LMS and Brisma IoT devices specifically designed to support Flipped Classroom model learning that is integrated with Knowledge Management and the Internet of Things. Future research can focus on how to plan and design a Flipped Classroom learning model that is integrated with IoT devices which can not only take multiple choice quizzes, but can also take quizzes in the form of essays. Knowledge manage-

ment can also be developed with mind mapping in the Smart Web Programming course.

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