Learning Management System (LMS) model based on machine learning supports 21st century learning as the implementation of curriculum 2013

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Abstract. The 21st Century learning is an effort to facilitate learners in the 21st century to experience the best learning experience so that they can achieve the learning objectives effectively. The 2013 curriculum is a shift in the 21st century education paradigm in Indonesia. One of the prominent features of 21st century learning is digital-based learning. Digital-based learning based on this research apply Learning Management System (LMS). The application of Machine Learning (Online Collaboration, Behavioural Tracking, and Learning Analytics) to LMS has great potential for realizing 21st century learning. The benefits of implementing machine learning are for LMS automation in the assessment of the 21st century learning process, making it easier for teachers to analyse learning outcomes. The purpose of this research is to create LMS model based on Machine Learning to support 21st Century Learning as the Implementation of Curriculum 2013. The utilization of machine learning shows positive result to 21st century learning process. Automated analysis can support the 21st century learning process.

1. Introduction
The 21st century skills are a series of skills that students must possess to be able to win a new era competition where competition begins to open globally. The 21st century is also marked by the number of (1) information available anywhere and can be accessed at any time; (2) faster computing; (3) automation that replaces routine jobs; and (4) communication that can be done anywhere and everywhere (Ministry of Education and Culture, 2013) [1]. One model that is currently quite potential is Information and Communication Technology (ICT) based learning in the form of a Learning Management System (LMS). Technology infrastructure is already a need to support 21st century learning [2]. Learning Management System (LMS) can be a missing link that unites contemporary education by using creative and innovative technology [3].

The 2013 curriculum in Indonesia is an effort to realize 21st century skills. Many institutions try to define 21st century skills, including: ATCS, UNESCO, EOCD, P21 and European. In harmony with Kyllonen, Binkley et.al. (2010, pp. 1-2) along with the Assessment & Teaching of 21st Century Skills (ATCS) agency said that structural analysis of 21st century skills was defined as 10 skills divided into 4 categories: (a) Ways of Thinking, (b) Ways of Working, (c) Tools of Working, (d) Living in the World [4]. These skills can be used as skill parameters needed today. The government seeks to prepare students to face global competition and modern trade which will soon occur by developing the 2013 curriculum [5-8]. One of the principles of the 2013 Curriculum Process Standard is about the balance of physical
skills (hard skills) and mental skills (soft skills) [9]. To support this, there are 3 Graduates Competencies, namely the dimensions of attitudes, knowledge, and skills [10]. However, defining attitude dimension competencies is still lacking to prepare students to face global competition.

The purpose of this study was to make a learning management system (LMS) model based on machine learning supporting 21st century learning as a 2013 curriculum implementation. The object of this study was conducted at Public Vocational High Schools in the city of Bandung. For the 21st-century learning method and skill achievement, the use of Machine Learning (Online Collaboration, Behavioural Tracking, and Learning Analytics) has great potential to make it happen. Other forms of information technology utilization that contribute to preparing 21st century learning are the use of MOOCs [11], video game based learning [12], the use of e-learning either using LMS (learning management system) or other learning applications [13], and the use of mobile learning as a learning medium in the 4 core competencies of 21st century learning [14].

2. Methods
This chapter discusses the use of Machine Learning (Online Collaboration, Behavioural Tracking, and Learning Analytics) on LMS for 21st century learning.

2.1. Online Collaboration.
Online collaboration learning is a solution for 21st century skills measurement. The use of online collaboration is by data mining clustering and using Influence diagrams, using tracking and assessment datasets. Online collaboration research-studies include:

- Anaya & Luque (2013) provide recommendations for group formation and provide decision-making assistance to online collaboration instructors to find out learning conditions during lessons. The method used is data mining clustering and using Influence diagrams, using tracking and assessment datasets of students who take part in online collaboration [15].
- Jagadish, (2014) to form a collaboration group that is balanced and mutually beneficial between individuals, a K Nearest Neighbour Rule clustering method is proposed based on the level of knowledge possessed by students in an online collaboration learning group. Students’ knowledge data will be processed and produce several study groups that are thought to have formed a balanced and mutually beneficial group. The data used is chat activity data on Moodle modules from all students who take part in online collaboration [16].
- Settles & Dow, (2013) examined social community forums to find out what factors influence an online collaborative, what is the right formation in collaborative online and the success and satisfaction of individuals in online collaboration. Using a combined method of quantitative results obtained from longitudinal behavioural data machine learning analysis, and qualitative results based on a survey of members of the community forum. This study found evidence that the equitable division of labor might be a factor that shows the success of online collaboration, namely good communication and knowledge sharing [17].

2.2. Behavioural Tracking
Behavioural Tracking aims to record to produce students' achievement and understanding values for which data is used by teachers to develop their daily learning materials and approaches. It is also a student guide to his own achievements and understanding. Related behavioural tracking studies include:

- In developing the MOCCLog system we basically focus on three principles or guidelines: a diverse set of stakeholders, a didactical approach and reuse of existing monitoring systems [18].

2.3. Learning Analytics
Learning Analytics is a way the system can recommend something to proceed to the next level, see from the data that has been obtained and processed in order to improve user quality and mind-set and
support a success both for social as a whole and students in the aspect of education. Related learning analytics studies include:

- “the measurement, collection, analysis, and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs” [19].
- “an emerging field in which sophisticated analytic tools are used to improve learning and education” [20].
- “the use of intelligent data, learner-produced data, and analysis models to discover information and social connections, and to predict and advise on learning” [19].
- “the use of data and models to predict student progress and performance, and the ability to act on that information”. On the other hand mention that LA is “students and their learning behaviours, gathering data from course management and student information systems in order to improve student success” [21].

3. Results and Discussion
Intelligence needs in developing i-Learning for CPS learning are carried out using the Intelligent Tutoring System (ITS) model approach. ITS has become a wide research area due to the many fields of disciplines involved such as education, psychology, cognitive science and computer science (artificial intelligent (AI)) [3]. Education will provide the best pedagogical method, psychology will provide the best communication method between ITS and users, cognitive science will teach the way knowledge works and computer science will transform the three sciences into a computer application that can be a replica of humans in teaching.

3.1. Basic architecture of ITS
Intelligence development in LMS is discussed based on the Intelligent Tutoring System (ITS) model. In general, the ITS system architecture consists of several components, namely the domain module, pedagogical module, student module, and interface module [3].

![Figure 1. ITS Domain [3]](image-url)
Domain Module is part of the scientific domain of education in curriculum subjects and learning materials. Domain Component Module or better known domain knowledge aims to store, manipulate and compile information on knowledge, concepts, and learning material to be taught. Pedagogical modules are part of the scientific domain of learning subject learning. In this study the pedagogical module discusses CPS learning. Pedagogical module serves to build lesson plans based on concepts of student knowledge, level of students’ domain knowledge, and level of understanding of concepts. This module also functions to choose, and compile evaluation concepts to measure student performance in the learning process.

Student Module is part of the cognitive scientific domain of student learning psychology. Discussion of cognitive science student learning psychology discusses the model of student learning styles (learning style models). This module component is used to store, monitor and analyse information about the student concerned such as how far the students have knowledge.

Interface Module is part of the scientific domain of computer science. Components used for communication intermediaries between systems and students. There is no standard rule in designing the interface / communication model part, but it should be designed as user friendly and responsive.

3.2. LMS Model for 21st Century Learning

The construction of the LMS architectural model for 21st century learning carried out an ITS architecture-based approach to the application of intelligence to LMS, and adjustments to business processes for 21st century learning. This chapter discusses the ITS-based LMS architectural approach, and the LMS model for 21st century learning.

3.3. The LMS architect for 21st century learning

The learning architecture based on LMS in Figure 3 is built based on the basic architecture of ITS. The components for each LMS module are as follows:

- **Pedagogical module**, contains components:
  - Selection of student learning models (LS).
  - Subjects taught.
  - The process of diagnosing student competencies.
  - Selection of intelligence agents for learning.

- **Domain module**, contains components:
  - Student learning subject.
  - Student competence.
  - Quiz along with the answer to the solution.

- **Student module**, contains components:
  - The process of updating student knowledge and information.
  - Student learning style data.
  - Student knowledge and information.

- **Module interface**, contains components:
  - Interface process for learning.
The intelligence intelligent (artificial intelligent) can be added to each component of the ITS model both the Pedagogical module, the Student Module, and the Interface Module [3]. Some methods in artificial intelligence in ITS that are often used include Bayesian Network, Fuzzy Neural, and Genetic Fuzzy [3]. The use of Machine Learning (Online Collaboration, Behavioural Tracking, and Learning Analytics) in LMS for 21st century learning is implemented in the form of intelligence agents for learning.

3.4. LMS model for 21st century learning

The LMS model for 21st century learning is based on 21st century learning business processes. The object of the research on the application of the LMS model for 21st century learning was carried out on vocational schools in Bandung, West Java. This research is expected to realize the recommended system of 21st century learning methods for the achievement of 21st century learning skills (Ways of Thinking, Ways of Working, Tools of Working, Living in the World).
4. Conclusion
From the research that has been done, the following results and conclusions are obtained: (1) the use of Machine Learning in the Model Learning Management System (LMS) supports the learning of the 21st Century. Machine learning utilization in LMS follows Online Collaboration, Behavioural Tracking and Learning Analytics functionality; (2) the development of the LMS model for 21st century learning uses ITS architecture. The artificial intelligent domain can be added to each component of the ITS model, both the Pedagogical module, the Student Module, and the Interface Module; (3) the implementation of the LMS model for 21st century learning is carried out in vocational schools in the city of Bandung. The LMS model still needs to be developed in prototype form and tested extensively.

This research is still limited to the proposed LMS model for 21st century learning by applying machine learning. Further research is needed to implement the LMS model for 21st century fire.

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