

Model of Learning Management System Based on Artificial Intelligence in Team-Based Learning Framework

Bens Pardamean
*Bioinformatics and Data Science
Research Center
Bina Nusantara University
Jakarta, Indonesia 11480
bpardamean@binus.edu*

Teddy Suparyanto
*Bioinformatics and Data Science
Research Center
Bina Nusantara University
Jakarta, Indonesia 11480
teddysup@binus.ac.id*

Tjeng Wawan Cenggoro
*Bioinformatics and Data Science
Research Center
Bina Nusantara University
Jakarta, Indonesia 11480
wcenggoro@binus.edu*

Digdo Sudigyo
*Bioinformatics and Data Science
Research Center
Bina Nusantara University
Jakarta, Indonesia 11480
digdo.sudigyo@binus.edu*

Andri Anugrahana
*Elementary School Teacher Education
Sanata Dharma University
Yogyakarta, Indonesia 55281
andrianugrahana@usd.ac.id*

Indri Anugraheni
*Elementary School Teacher Education
Satya Wacana Christian University
Salatiga, Indonesia 50711
indri.anugraheni@uksw.edu*

Abstract—The presence of various innovations and technology of Artificial Intelligence (AI) has now begun to be adopted by Indonesia in many aspects including in the industrial sector. The utilization of AI also can offer a new paradigm in learning and teaching strategies. The development of learning strategies continues also performed to obtain the variations of learning that involve student activity. Team-Based Learning (TBL) is one of the teaching strategies that can improve the quality of the learning process and student activity in groups. By starting to integrate digital-based learning resources in the learning and teaching process, the TBL strategy can potentially be an alternative to new learning strategies that are relevant to be applied in the era of the educational revolution 4.0. The main focus of this research is to develop and evaluate the application of AI in a digital-based TBL strategy that will be implemented in the form of personalized learning about student learning styles. This research was developed based on the learning strategy development of the research method. However, this article more focuses on developing the AI application design that will be applied. The application design was developed based on the agile development method, especially SCRUM. The result of this study is an additional feature that was implemented on a Learning Management System (LMS) based on the Modular Object-Oriented Dynamic Learning Environment (MOODLE).

Keywords—Artificial Intelligence, Team-Based Learning, Personalized Learning, MOODLE

I. INTRODUCTION

Today, the majority of teaching and learning practices are focused on conventional didactic approaches, such as face-to-face classes, case study seminars, and/or tutorials. The teacher provides instruction to students by standing at the front of the class, teaching, explaining concepts, facts, and other lessons. Due to the limited face-to-face time, students can only listen, absorb, and memorize what the teacher said during the learning process. For students outside of the classroom, certain tasks, such as homework, concepts, and reviewing questions from other activities, are additional to the learning process. The traditional didactic teaching approach is currently unable to optimize students' ability in the learning process and in comprehending teaching materials. This style of instruction focuses solely on learning concepts and ideas. However, previous studies stated that

effective teaching methods necessitate students to participate actively in the learning process [1–4]. The Team-Based Learning (TBL) method can be applied as a strategy to solve the above problems. TBL provides opportunities to develop students' abilities in teamwork and promote active learning [5]. This process aims to form a combination of understanding of the general management process applied to specific planning and management themes for each group. Therefore, the study group can trigger hard skills and soft skills related to cooperation, initiative, communication, and presentation [6].

The initial stage of learning with the TBL method is that the teacher provides various learning resources for the independent learning stage before face-to-face learning in class begins. Variations of these learning sources include learning through video lectures, animated videos, slides, e-books, and internet articles. These learning resources can be organized by the teacher in a Learning Management System (LMS) online portal to facilitate students for access. The independent learning process in TBL can run successfully if there are various choices of learning resources for each teaching material based on the learning styles of each student. For this process to run well, an accurate predictive method of learning styles is needed for each student, so that students can understand the teaching material easily. Besides predicting learning styles will also help in the process of forming a group or team.

Learning styles can be determined using a questionnaire as an instrument. However, this approach still does not catch the specific learning styles per student. Even though students' choices in independent learning sessions can reflect the learning styles of each student. Furthermore, students' past learning achievements can also be used to see whether the learning styles used by students today are appropriate or not. These two indicators are still not being utilized in the current TBL process to determine the appropriate learning style for each student. Based on the problems above, this research aims to create a digital learning system based on Artificial Intelligence (AI), to solve the problems which include:

- Creating a learning resource recommendation system on an online learning portal based on the learning styles and

achievements of each student by the principles of Personalized Learning in the independent learning process using the TBL method.

- Forming groups based on the learning styles and achievements of each student.

The output produced from this research is a digital learning application within the TBL framework equipped with AI technology to recommend learning sources and predict the learning styles of each student.

II. LITERATURE REVIEW

A. Team-Based Learning

Team-Based Learning (TBL) is learning that involves several students so that they create a learning team to develop the hard skills and soft skills of each student. There is no need for several spaces, students' readiness in the class, and individuals or small groups of students (teams) are responsible for contributing to team productivity, which sets TBL apart from Project-Based Learning (PBL) and other small group approaches. Instructors must be experts at delivering content, but do not need to have experience or expertise in group processes to conduct a successful TBL session. Students do not need further training in teamwork because they learn how to collaborate and be effective as a result of the process. TBL may be used in place of or in addition to a lecture-based course or program [7].

The main learning objectives in TBL are to achieve more than just covering content, and a change of focus in the other direction ensures that students can apply what they have learned in the course by solving problems [1,8]. TBL is intended to provide conceptual and procedural information to students [9,10]. Although some class time is still spent ensuring that students understand the course material, the majority of class time is allocated to team assignments that concentrate on problem-based learning by simulating the challenging questions that students would encounter during a developmental assessment course [1].

According to Bonwell [11], the characteristics of TBL are expected to obtain several things, that is:

- The interactions that occur during the learning process will lead to positive interdependence in which information consolidation can only be achieved by active learning exploration.
- Each student must be actively engaged in the learning process, and the teacher must be expected to assess each student so that individual accountability is established.
- This active learning process to function properly necessitates a high degree of effort in order to develop social skills.

B. Personalized Learning

Personalized learning can be regarded as a comprehensive integration across the school and the intensification of these ideas across all grades also subject areas. This system has become more proper recently through the availability of technology support [12]. Personalized allows students to get the instruction and direction they need [13,14]. Personalized learning can also allow the details of which is better in the coverage of topics and flexible pathways for student success. Where a student would conventionally take courses in

calculus, statistics, or accounting, the system-based mastery can allow the student to learn the selected parts of each of the subjects, adapted to the interests of students, or to meet the demands of the career path desired [12].

Personalized learning, in particular digital personalized learning with a curriculum that has been packaged previously, the assessment and data collection constantly is a clear area of growth students in learning at this time [14,15]. Personalized learning in a digital platform can be realized by using AI. One of them is applied in determining the learning styles of the students concerned. Learning style can be defined as the tendency or the way students absorb and communicate information effectively. Where it can be represented in the speech patterns, how to learn, how to work on a task, how to respond to others, and other activities that are preferred [16].

C. E-Learning dan Learning Management System

The word "e-learning" was first used in October 1999 at the Computer Based Training (CBT) System seminar in Los Angeles, California [17]. This word is associated with online learning (online). E-learning includes two domains of knowledge, namely education and technology utilization. In Indonesia, according to Law no. 20 of 2005 [18], e-learning is closer to the definition of distance education. According to the general provisions in the Act. No.20 of 2003 [19], distance education is a type of education in which students are segregated from their teachers and must learn from a variety of sources such as information, communication technology, and other forms of media. However, e-learning is widely understood as learning in the Internet network (online) or online learning. In e-learning, information technology becomes a bridge of interaction between teachers, students, and learning content. Figure 1 shows the interactions between students, teachers, and content in e-learning. E-learning is also a medium of communication between students, between teachers, and between learning content itself [20]. In practice, e-learning requires Learning Management System (LMS) features.

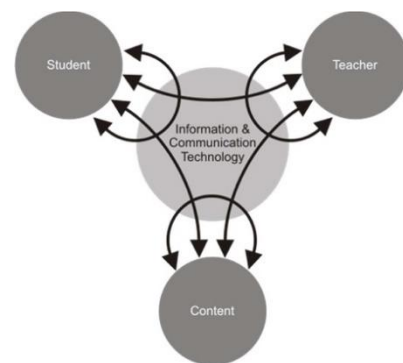


Fig. 1. Interaction of Students, Teachers, and Learning Content in e-Learning [21]

LMS is "an information system that administers instructor/teacher-led online courses (online learning) and tracks student progress" [22–24]. One feature that can be used as an LMS is MOODLE. Modular Object-Oriented Dynamic Learning Environment (MOODLE) is an open-source Course Management System (CMS), also referred to as a Virtual Learning Environment (VLE) or LMS [25,26]. MOODLE is

a PHP and MySQL-based open-source web application [27]. MOODLE was built using open-source software, including Linux (www.linux.com) as the operating system, Zope (www.zope.org) as the application server, Python (www.python.org) as a programming environment, Apache (www.apache.org) as a web server gateway, and some Unix shell scripts to manage the system when it was first developed [28].

III. METHODOLOGY

The research method in this study adopts development research steps according to Sugiyono [29], and will only operate the first 6 of the 10 developed steps. Figure 2 shows the 6 research steps that will be operated as a whole in this study. However, in this paper, the process that will be discussed is more about the results of the product design that will be implemented. The design of this product will be developed and piloted to students-elementary school students in Yogyakarta, Salatiga, and Jakarta.

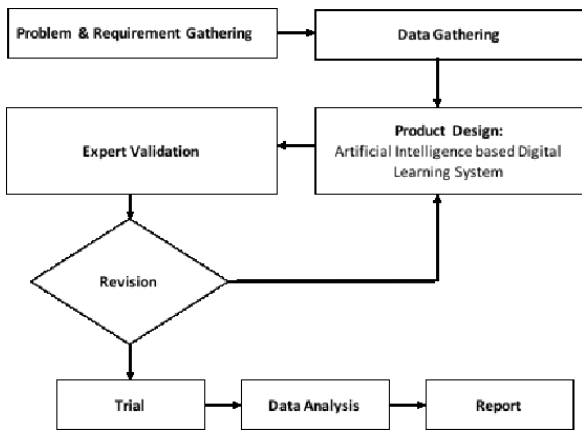


Fig. 2. Research and Development Process

The project management model that will be applied in this project is one of the models of the development of agile, especially SCRUM [30]. This management model enables agile software development in the face of change. Therefore, it is more appropriate with the characteristics of software requirements that have fast dynamics. SCRUM management process generally can be illustrated in Figure 3. The overall feature design process in this study will be executed in four stages, each of which follows the SCRUM workflow. The four stages are (1) Creating an online learning portal based on MOODLE; (2) AI module creation; (3) Integration of online portals and AI modules; and (4) Testing in a real environment. For each stage, we will put several tasks in the backlog according to our understanding of how the system should be implemented. Afterward, we will run several sprints to complete the task in the backlog. The intermediary output from each sprint will be demonstrated to the teachers in the selected primary school as the product owner. The feedback from the teachers will be considered to discard unnecessary tasks and put new tasks to adapt to the change that might arise from the feedback.

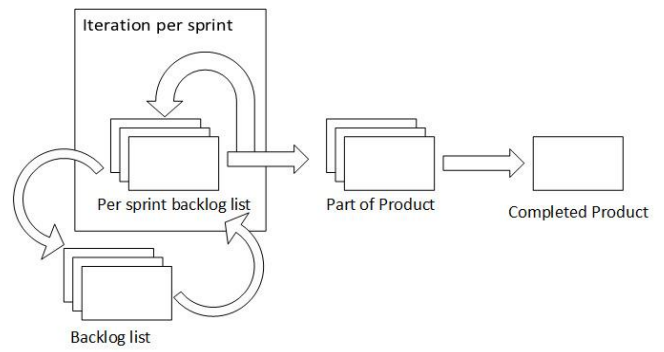


Fig. 3. Research and Development Process

IV. RESULT AND DISCUSSION

The application to be developed in this research is an online learning portal that utilizes the TBL learning framework enhanced with AI technology. The application of AI technology is intended to create personalized learning skills in the developed online portal. AI logic flow used in this online portal can be divided into five parts, especially AI training to determine learning styles, AI training on material recommendations, determining learning styles, determining study groups, and the learning process. This logic flow was specifically designed to fully utilize the capacity of an AI model based on collaborative filtering. The logic flow of each of these sections is illustrated in Figure 4 to Figure 8.

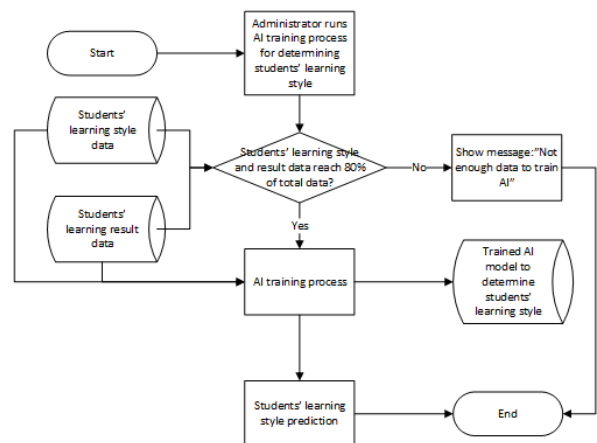


Fig. 4. Logic Flow of AI Model Training to Determine Learning Styles

In Figure 4, the process to train the AI model for learning style prediction is explained. The process is initiated by an administrator. When the process is started, it checks the database of the students' learning style and result that has been collected previously by the learning platform. If the data is sufficient, the system trains the AI model to store it in a database for later prediction. At the same time, the system returns the prediction of the students' learning style prediction after the training process is completed.

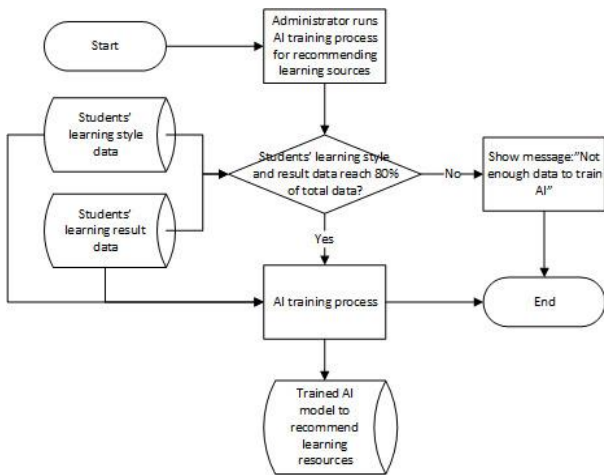


Fig. 5. Logic Flow of Training Model AI Learning Media Recommendations

A similar logic flow is employed to train the AI model for the recommendation of learning media, as depicted in Figure 5. The process is also initiated manually by the system administrator. Once the students' learning style and result data are enough, the training process is started. The only difference is that the model is stored in a different database because the system now trains a different AI model.

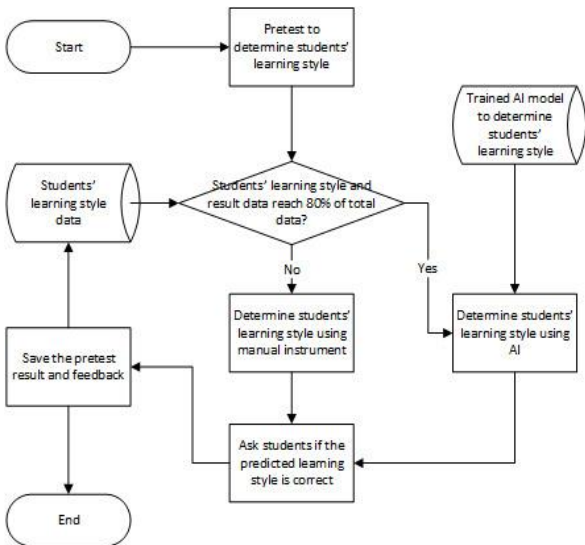


Fig. 6. Logic Flow of Determining Learning Styles

The process of collecting data to train the AI for learning style prediction is depicted in Figure 6. To get the learning style ground truth to train the AI for learning style prediction, several students' are assessed using a manual instrument to determine their learning style. If the AI has been trained, the learning style is predicted by the AI instead. To validate the predicted learning style, whether it is determined by a manual instrument or predicted by AI, it is shown to the students to inquire them if the result is true or not according to themselves.

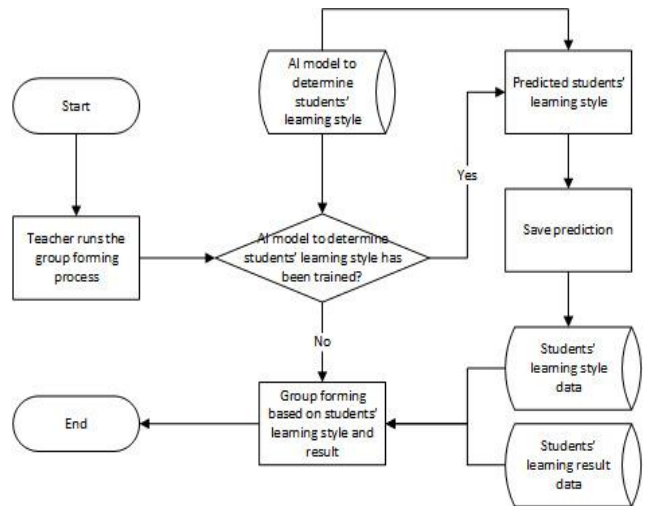


Figure 7. Logic Flow of Determination of Study Groups

In Figure 7, we illustrated the logic flow that let the learning platform forming groups of students to facilitate team-based learning. The groups are formed by balancing the members' learning styles as predicted by the AI for learning style prediction. The process is initiated by the teacher whose students use the learning portal. Afterward, if the AI has been trained, it provides the predicted learning style of the students. Based on this prediction, the system divides the students into groups where each group has a relatively balanced learning style.

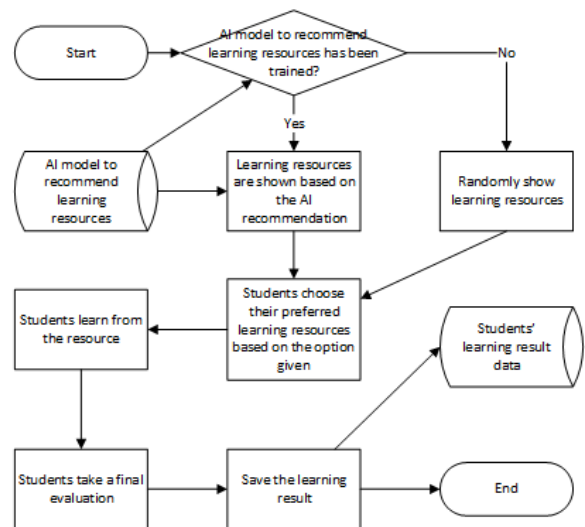


Fig. 8. Logic Flow of Independent Learning Process

Finally, while learning using the learning portal, the students will be provided with learning resource recommendations. If the AI for a recommendation has been trained, the students will receive a recommendation from AI. Else, they will receive random recommendations. Each time the students access the recommended learning resources, their history is recorded along with their performance on the final test. This data can be used to train the AI again to improve the quality of its recommendation in the future.

The technology applied to develop the online portal is an open-source learning platform called MOODLE. This platform was chosen because of characteristics that allow it to be created according to the requirement. These characteristics are required because the incorporation of AI technologies into the TBL framework is a unique concept and difficult to implement in a rigid platform. MOODLE flexibility is possible because this platform was developed with the PHP programming language and MySQL database, which has been popularly used for the development of web-based applications.

The Moodle-based online portal will then be integrated with the AI module developed using the Python programming language. This AI module will be created as a web application in a service-oriented architecture, thereby facilitating communication between the online portal and the AI module. So the module of AI can be created into a web application, then in this research will be operated as a Python-based web framework called Flask. To ensure the reliability of the AI module, AI algorithm development will utilize a Python library called PyTorch [31]. This library has been popularly used for the development of modern AI algorithms, specially included in the Deep Learning category.

TABLE I. MODEL PERFORMANCE ON TRAINING, VALIDATION, AND TEST SET

Metrics	Training	Validation	Test
MSE	0.4221	0.7512	0.8343
RMSE	0.6497	0.8667	0.9134

TABLE II. COMPARISON OF PREDICTED LEARNING STYLE RESULTS FROM TEACHERS AND AI

		Teacher Prediction		
		Visual	Auditory	Kinesthetic
AI Prediction	Visual	15%	6%	6%
	Auditory	17%	3%	10%
	Kinesthetic	23%	7%	13%

The comparative evaluation of the prediction of teacher learning styles with AI predictions shows a reciprocal result of 35.90% in Table II. Results of this study show a shift in learning style between face-to-face learning and online learning in Table I. This result was validated and tested by the prediction of AI learning styles. The performance of the AI model that is applied is quite satisfying and objective. Roy Clariana and Lana Smith's research also shows a shift in learning styles [32]. Flexible online learning styles affect these learning styles [33]. In addition, changes in student learning environments and individual maturity levels also lead to learning styles shifting. The subjects selected frequently in the adolescents were in the age range of 11 to 14 years old. At this age, it is a transitional period from childhood to adulthood. Therefore, a shift in learning styles can occur in elementary school students with online learning. To validate the model, a pre-post experiment will be conducted to observe whether the students that use the AI module improved their performance. A t-test will be conducted on the experiment data to test the hypothesis that the AI model can improve the students' performance.

V. CONCLUSION

The development of learning strategies is performed to obtain the variations of learning that involve student activity and learning media. TBL is one of the teaching strategies that can improve the quality of the learning process and student activity in groups. By starting to integrate digital-based learning resources in the learning and teaching process, the TBL strategy can potentially be an alternative to new learning strategies that are relevant to be applied in the era of the educational revolution 4.0. In running digital learning and online, the usage of the LMS has become very crucial.

MOODLE is one of the LMS that is capable and can be developed again as an LMS that adopts personalized learning. The teaching materials in the LMS can be given according to the learning style of each student. The suitability of teaching materials with the learning styles of each student is expected to improve student learning outcomes. Also, student activity can be improved through the usage of TBL in the learning process. With the modifications, MOODLE can facilitate teachers to improve student learning outcomes and student activity.

For future study, the number of subjects and schools for the AI development phase can be increased. Additionally, instrument learning outcomes based on questionnaires and grades can be applied. This instrument obtains information on the effectiveness of the learning-style-based teaching-learning process.

REFERENCES

- [1] Pardamean B, Prabowo H, Muljo H, Suparyanto T, Masli E, Donovan J. Team based learning as an instructional strategy: A comparative study. *New Educ Rev* 2017. <https://doi.org/10.15804/ner.2017.50.4.11>.
- [2] Andro B, Pardamean B. Team Based Learning in Computer Science Students, 2017. <https://doi.org/10.1109/ICSITech.2017.8257128>.
- [3] Pardamean B, Suparyanto T, Masli E, Donovan J, others. Enhancing the use of digital model with Team-Based Learning approach in science teaching. *Inf. Commun. Technol. Conf.*, 2014, p. 267–76.
- [4] Prabowo H, Cenggoro TW, Budiarto A, Perbangsa AS, Muljo HH, Pardamean B. Utilizing Mobile-based Deep Learning Model for Managing Video in Knowledge Management System. *Int J Interact Mob Technol* 2018;12:62–73.
- [5] Fink L. *Creating Significant Learning Experiences: An Integrated Approach to Designing College Courses* / L.D. Fink. 2005.
- [6] Mayona EL, Irawati I. Penerapan Model Team Based Learning pada Mata Kuliah Pengantar Pengelolaan Pembangunan. Bandung Itenas Moye, Pamela M, Metzger 2009.
- [7] Parmelee D, Michaelsen LK, Cook S, Hudes PD. Team-based learning: A practical guide: AMEE Guide No. 65. *Med. Teach.*, 2012. <https://doi.org/10.3109/0142159X.2012.651179>.
- [8] Pardamean B, Suparyanto T, others. Improving problem-solving skills through Logo programming language. *New Educ Rev* 2015;41:52–64.
- [9] Michaelsen LK, Sweet M. The essential elements of team-based learning. *New Dir Teach Learn* 2008. <https://doi.org/10.1002/tl.330>.
- [10] Pardamean B, others. Enhancement of creativity through logo programming. *Am J Appl Sci* 2014;11:528.
- [11] Michaelsen L, Knight AB, Fink L. *Team-Based Learning: A*

- Transformative Use of Small Groups in College Teaching, 2002.
- [12] Pane J. Strategies for Implementing Personalized Learning While Evidence and Resources Are Underdeveloped. 2018. <https://doi.org/10.7249/pe314>.
- [13] Kim A. Personalized Learning Playbook. Igarss 2014 2014. <https://doi.org/10.1007/s13398-014-0173-7.2>.
- [14] Xiao F, Pardamean B, others. MOOC model: Dimensions and model design to develop learning. *New Educ Rev* 2016;43:28–40.
- [15] Boninger F, Molnar A, Saldaña CM. Personalized learning and the digital privatization of curriculum and teaching. Natl Educ Policy Center) Whitepaper Accessed <https://Nepc Color Edu/Publication/Personalized-Learning 2019>.
- [16] Nugraheni E, Pangaribuan N. Gaya Belajar Dan Strategi Belajar Mahasiswa Jarak Jauh: Kasus Di Universitas Terbuka. *J Pendidik Terbuka Dan Jarak Jauh* 2006.
- [17] Leeuwe M. E-Learning Fundamentals. *Leerbeleving* 2009. <http://www.leerbeleving.nl/wbts/1/index.html> (accessed August 15, 2020).
- [18] Indonesia Pr. Undang-undang Republik Indonesia Nomor 14 Tahun 2005 tentang Guru dan Dosen 2006.
- [19] Indonesia Pr. Undang-undang Republik Indonesia nomor 20 tahun 2003 tentang sistem pendidikan nasional. Jakarta Pemerintah Republik Indones 2003.
- [20] Pardamean B, Suparyanto T. A Systematic Approach to Improving E-Learning Implementations in High Schools. *Turkish Online J Educ Technol* 2014;13:19–26.
- [21] Suparyanto T, Pardamean B. The Effects of Computer Skill in Student's Achievement through the Use of Learning Management System. *Conf. Int. Semin. Integr. Technol. into Educ.*, 2010.
- [22] Brown, A. & Johnson J. Five Advantages of Using a Learning Management System. *Microburst Learn* 2003. www.microburstlearning.com. (accessed August 15, 2020).
- [23] Pardamean B, Suparyanto T, Kurniawan R. Assessment of graph theory e-learning utilizing learning management system. *J Theor Appl Inf Technol* 2013;55:353–8.
- [24] Gunawan K, Pardamean B. School Information Systems Design for Mobile Phones. *J Comput Sci* 2013;9. <https://doi.org/10.3844/jcssp.2013.1140.1145>.
- [25] Moodle. Moodle Doc. Moodle 2010. <http://docs.moodle.org/en> (accessed August 15, 2020).
- [26] Pardamean B, Wijayakusumah A. 3-D Interface Design Of The Virtual World In E-Learning. *J Theor Appl Inf Technol* 2014;62:1–11.
- [27] Selvi RT, Meenakshi R, Balasubramanian N V, Manohar GT. Framework and architectural style metrics for component based software engineering. *WSEAS Int. Conf. Proceedings. Math. Comput. Sci. Eng.*, 2008.
- [28] Dougiamas M, Taylor PC. Improving the effectiveness of tools for Internet-based education 2000.
- [29] Sugiyono. Metode penelitian pendidikan:(pendekatan kuantitatif, kualitatif dan R & D). Alfabeta; 2008.
- [30] Schwaber K. Scrum development process. *Bus. object Des. Implement.*, Springer; 1997, p. 117–34.
- [31] Paszke A, Gross S, Massa F, Lerer A, Bradbury J, Chanan G, et al. Pytorch: An imperative style, high-performance deep learning library. *Adv. Neural Inf. Process. Syst.*, 2019, p. 8026–37.
- [32] Clariana RB, Smith L. Learning Style Shifts in Computer-Assisted Instructional Settings. London: C. V. Mosby Company; 1988.
- [33] Zapalska A, Brozik D. Learning styles and online education. *Campus-Wide Inf Syst* 2006;23. <https://doi.org/10.1108/10650740610714080>.