



# Adaptive Learning Analytics Management System (Alams): An Innovative Online Learning Approach

Ence Surahman<sup>a</sup>, Dedi Kuswandi<sup>b</sup>, Agus Wedi<sup>c</sup>, I Nyoman Sudana Degeng<sup>d</sup>, Dini Aris Setyanti<sup>e</sup>, Zahid Zufar At Thariq<sup>f</sup>

Departement of Educational Technology, State University of Malang, Indonesia

Email: <sup>a</sup>[ence.surahman.fip@um.ac.id](mailto:ence.surahman.fip@um.ac.id), <sup>b</sup>[dedi.kuswandi.fip@um.ac.id](mailto:dedi.kuswandi.fip@um.ac.id), <sup>c</sup>[agus.wedi.fip@um.ac.id](mailto:agus.wedi.fip@um.ac.id),  
<sup>d</sup>[nyoman.sudana.d.fip@um.ac.id](mailto:nyoman.sudana.d.fip@um.ac.id), <sup>e</sup>[diniaris7@gmail.com](mailto:diniaris7@gmail.com), <sup>f</sup>[zahidthoriq123@gmail.com](mailto:zahidthoriq123@gmail.com)

Online learning in some universities in Indonesia have experienced a significant development in the last ten years. However, most services are presented uniformly for all learners. The homogeneity in the sense of service is not celebrated in the diversity of learners' preferences. This study aims to develop online learning services that can adapt to the characteristics of learners in particular learning style. The method used in the form of research and development (R & D). Stages of research began with the analysis of the characteristics of learners, then the development of services that can adapt to the characteristics of learners was considered. The next phase tests the online learning that has been implemented. Based on the results of the expert judgments Alams can facilitate the diversity of learners. In addition, the learning process can be effective as evidenced by the achievement of learning outcomes of learners who exceed the target set.

Keywords: alams, adaptive learning, learning analitic, online learning, blended learning

## INTRODUCTION

The development of electronic learning in be a blended platform using a Learning Management System (LMS) and has been developing since the emergence of the Internet and its adoption in the world of learning. Learning to use the Learning Management System (LMS) can be either blended to study in person or online. Both have their advantages and limitations. Blended learning has a positive impact on the learning process (Brali & Divjak, 2018), (Lotrecchiano, McDonald, Lyons, Long, & Zajicek-Farber, 2013).

There is pre-existing research that examines the online learning using LMS. However, not many researchers are developing the LMS to be adaptive to the learners. In fact the learning preferences of each learner is different. Preference learning is a tendency one can learn optimally. There are several theories and models of learning preferences and factors that can affect one's learning preferences (Prastiti & Pujiningsih, 2009). In general, learning preference models can be classified in three spheres, namely information processing, environment, and personality. Several instruments to assess one's learning style have been developed by several experts, among others developed (Bower, 2013; Mainemelis, Boyatzis, & Kolb, 2002), known as Learning Style Inventory (LSI) or Kolb'LSI. The model was developed by Carl Jung who became known as the Myers-Briggs Type Indicator (MBTI). Multiple Intelligence Model developed by (Gardner, 1992). Another model developed by Canfield is called the Learning Style Inventory (Canfield'LSI).

Examples based on sensory learning preferences of students learning style preferences can be divided into visual, auditory, and kinesthesia (Surahman & Surjono, 2017). Learners dominant visual learning style are characterised by satisfied to see the teacher demonstrate the material in front of the class, or read textbooks, view video, multimedia animation and images in textbooks. As for students who have a predominance of auditory learning style tend to prefer teachers present material orally, listening to the material of audio recordings and narrated by his friend (Temitope Favour Jiboye, 2019). While students who have more kinesthetic learning style were pleased to learn when he can do what he was studying it for himself, casusing the motor nerve to be activated.

The analysis process and characteristics of learners in a learning activity is called Analytic learning (Siemens, 2013). Learning analytics is the measurement, collection, analysis and reporting of data about learners and in context of understanding and optimising the teaching and learning environment (Dietz-Uhler & Hurn, 2013), (Olmos & Corrin, 2012). Learning analytics are able to predict and improve the success of retention of learners and this is due to the decision making process in the learning process being based on the data available in the learning management system (LMS) (Olmos & Corrin, 2012). Learning analytics need to be adopted in the learning management system for the purpose of data analysis of the learning process.

The application of learning analytics should also be applied in the packaging of media presentation of learning, given the media have an important role in learning (Smaldino, 2012; Tumbel, 2018). Learning media has contributed to delivering a message that learning can be more standardised, learning can be more interesting, learning has become more interactive by applying learning theory,



the execution time of learning can be shortened, the quality of learning could be improved, the learning process can take place whenever and wherever needed, a positive attitude towards learning material, the learning process can be improved and the teacher's role can change in a positive direction (Kemp, Dayton, & Kemp, 1985).

Different learning preferences show the fastest and best way for an individual to take on information. In the context of learning, faculty efforts in presenting instructional strategies and instructional media is important to pay attention to the dominant learning styles of the students, it aims to help learners master the information and learning materials quickly and accurately (Moreno & Mayer, 2000; Surahman & Surjono, 2017; Ziaurrahman & Surjono, 2018).

The diversity of learning can inspire individualised learning approaches, being the approach to learning that seeks to help learners resolve the problem personally. Considering the problems each learner has are diverse, efforts to help learners resolve its problems also must be with an individual approach (Gaševi, Dawson, & Siemens, 2015; Lim, Dawson, Joksimovic, & Gaševi, 2019; Verbert, Duval, Klerkx, Govaerts, & Santos, 2013). There have been various efforts to assist the completion of individual learning problems. One effort that can be achieved is by an adaptive learning, being learning which fits perfectly with the needs and characteristics of learners. In addition, adaptive intelligence level learners to encourage learners to master the objectives and adaptive to the dominant learning style.

Implementation of adaptive learning can also be realised in the choice of methods, strategies, materials, resources, assignments or evaluations and development of instructional media used in the learning process (Surjono, 2011). In the development of adaptive learning media it has proved effective in the process of achieving the learning objectives of e-learning compared to non-adaptive alternatives (Surjono, 2011). E-learning is an adaptive e-learning services presented adaptively to a range of learning styles. The service is presented from the analysis of learning styles and characteristics of learners.

Developing adaptive e-learning can be developed and studied more deeply, especially the differences in learning strategies undertaken in the LMS. Two learning strategies in the LMS are synchronous and asynchronous. Synchronous strategy is conducted simultaneously between facilitators and learners. While the asynchronous strategy can be done without having to be online. In this study, students as learners are given the opportunity to express themselves in the form of document learning outcomes. Learning management through individual, independent, group, and classical are expected to be able to provide improved liveliness and creativity of students.

## **METHOD**

The model used is a model research and development (R & D) proposed by Lee & Owens, (2004). The reasons for selecting this model is because it is a model that is considered relevant to the product being developed. In addition, this development model is said to be a procedural model for the sequence of steps in the process of systematically arranged (Akbar, 2016).

The procedure of research and development in the model (Lee & Owens, 2004) consists of five stages (Figure 1): (1) assessment / analysis which includes the analysis of needs (needs assessment) and a preliminary analysis of the end (front-end analysis), (2) design, (3) development, (4) implementations, and (5) evaluation.

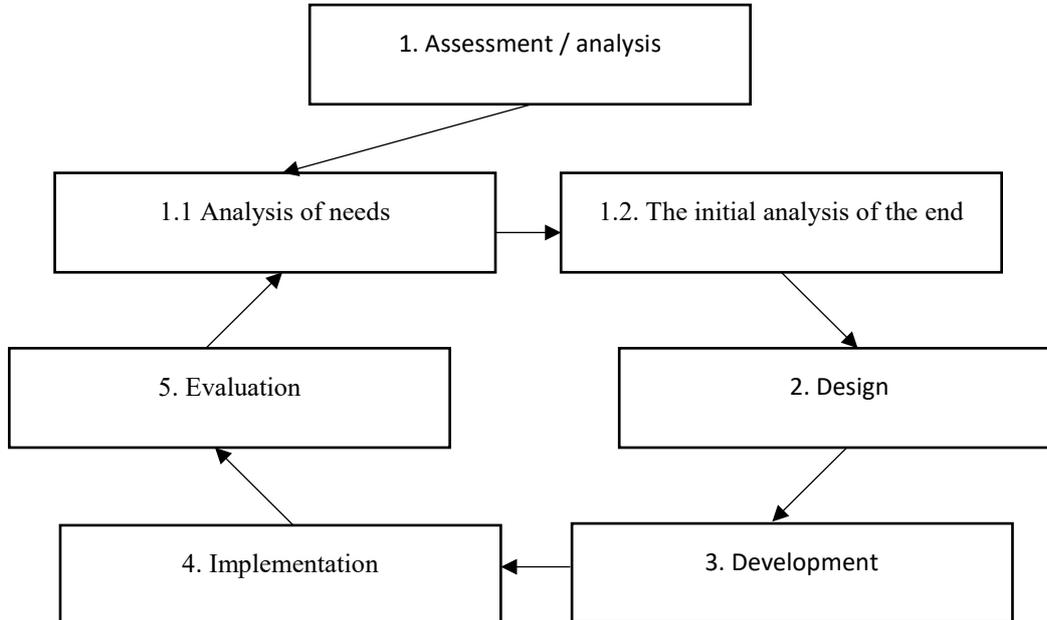


Fig 1. Model Development Prosedur (Lee & Owens, 2004)

In its application the development model is modified according to the needs. Thus the design of the development of Adaptive Learning Analytics Management System (ALAMS) is as follows:

- a. Analysis of Adaptive Learning Analytics Management System (ALAMS) using a learning style inventory. There are 25 questions to identify the learning style preferences of learners. In addition, there is needs analysis process carried out by using an analytical approach. Some of the software needed for the analysis process LMS include Google analytics, analytics and Intelliboard Piwik.
- b. Design of Adaptive Learning Analytics Management System (ALAMS) in the form of learning scenarios from the initial meeting to end. Learning scenarios in question is the learning activities at each meeting from beginning to end of the course presented in LMS MW can be accessed via [e-learning.um.ac.id](http://e-learning.um.ac.id) student. General learning scenarios include: 1) orientation lecture, 2) submission of an introductory lecture, 3) discussion and presentation of the results of the study group, 4), midterms, 5) enrichment lecture material, 6) performing tasks and projects lectures, 7) reflection lecture, 8) final exams.
- c. Development of Adaptive Learning Analytics Management System (ALAMS) in [e-learning.um.ac.id](http://e-learning.um.ac.id). development in question is the integration of analytics tools that have been the class of the LMS doing research.
- d. Validation program developed was on the assessment of experts. Validation aims to prove the feasibility of the products developed.

- e. Application of Adaptive Learning Analytics Management System (Alams) products in lectures. The intended application is the use of Alams in the LMS during the course including the tabulation process result data analytics tools.
- f. The data analysis test results Adaptive Learning Analytics Management System (Alams) program in lectures. The analysis in question is the process of reading data analytic results based on the likelihood of data that has appeared. For example, data on the duration of learners to access the LMS, the time duration of the quiz, the tendency hour student access, the percentage of students who are consistent in learning and lecturing tasks and others.
- g. Dissemination of the development of Adaptive Learning Analytics Management System (Alams). Dissemination is done in some activities such as the collection and presentation of the results of the development report, presentation of research papers in the conference and the publication of scientific papers in journals.

Design Scheme of Adaptive Learning Analytics Management System (ALAMS) can be seen in Figure 2.

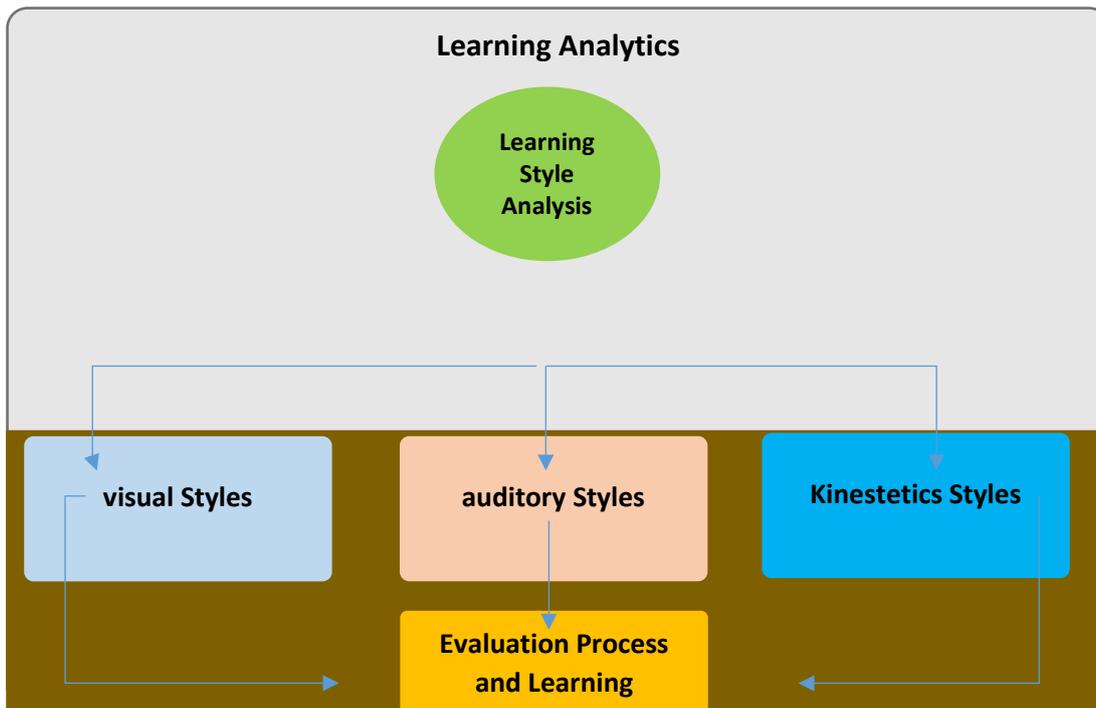


Fig 2, Scheme Adaptive Learning Analytics Management System

Adaptive online learning products are implemented in the lecture Model Curriculum Development (MPK). The course aims to equip learners to understand and analyse the advantages and disadvantages of each model that is in addition to understanding the components and phases. At the end the learners are required to develop a curriculum innovation based on the results of analysis of the problems they find.

The number of participants in this study are all students of curriculum concentration are as many as 31 students. Curriculum is one of the concentration of knowledge of educational technology in



science education faculty State University of Malang. Participants can be involved is limited to students who take the concentration of the curriculum. In general, these students enter college semesters 7. With the number of both men and women as much as 40% to 60%. The average age of participants at around 21 years. Before taking courses in curriculum development model, the participants are getting an introductory course curriculum, compared to curricula and curriculum development approach.

## RESULTS

In an adaptive e-learning developed with two different learning strategies that generate synchronous and asynchronous learning, students are given the opportunity to express themselves in the form of documents learning outcomes. Learning management through individuals and groups, and the traditional method proven to provide increased liveliness and creativity of students.

The resulting was namely, 1) Adaptive Learning Analytics Management System (Alams), a platform capable of facilitating learning in a variety of different characteristics of learners, 2) differences in the characteristics of learners is based on the tendency of learning styles that emerged after analysis using a learning style inventory. Moreover, it can be done with the help of some software web analytics such as Google Analytics, Piwik Analytics, and IntellBoard, 3) study room is designed on online learning environment and learning objects are presented according to the characteristics of learning styles of learners, 4) development of smart online learning environment is an innovation of smart learning environment network, 5) Adaptive management handbook Learning Analytics management System (Alams).

### 1. Online Courses in E-learning

Adaptive Learning Analytics Management System (Alams) Platform capable of facilitating learning in a variety of different learner characteristics was developed in the Learning Management System (SIPEJAR UM). Because the platform is still at the UM SIPEJAR the course of Curriculum Development Model developed only it and it can not make the class online. Model Alams in the course of Curriculum Development Model provides facilities to students with a wide range of characteristics. Figure 3 shows the display of the online learning.

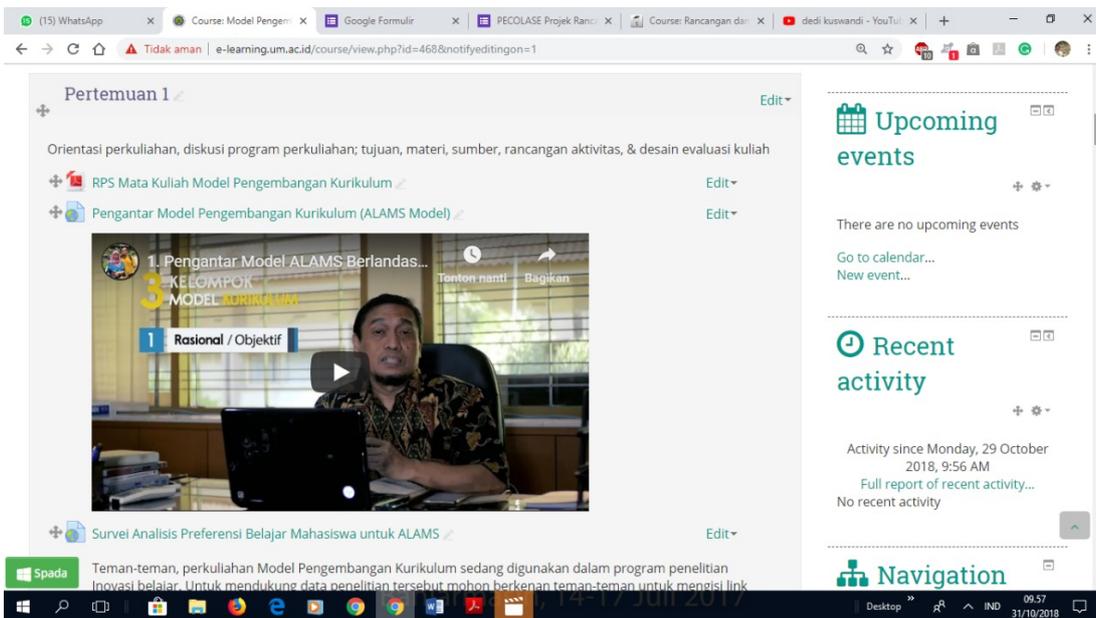


Fig 3. Display online learning in LMS

The first meeting of the lecture will present lesson plan of Curriculum Development Model (MPK) courses that can be downloaded in PDF format, and the introduction of online video courses Curriculum Development Model (Alams Model) that can be played at that time. The following pages college courses Curriculum Development Model: <http://e-learning.um.ac.id/course/view.php?id=468>

## 2. Application Analysis Form Online learners to Develop Adaptive LMS

Form online learners analysis on the Figure 4 below to find out an assessment of the products developed.

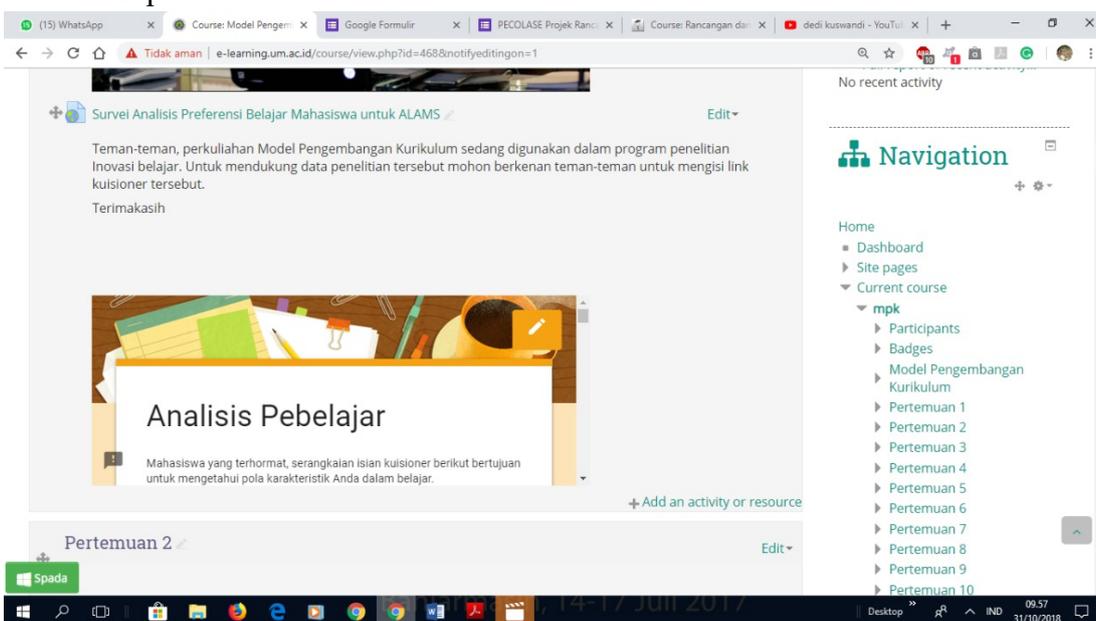


Fig 4. Analysis Features .Tampilan learners to Develop Adaptive LMS

Development of the analysis during the initial encounter of lectures aims to gather information for learners. The information extracted includes demographic learners. Besides more aspects related to the analysis of learning preferences, learning styles and trends analysis service options of learning was favored by learners. Based on the analysis performed some information found that the participants were evenly derived from rural and urban areas. The participants were spread havinf varied learning styles. There were inclined visual, auditory, and kinesthetic. It has implications for the tendency learning services. Some learners enjoy learning in a quiet atmosphere, but some admitted to not be bothered by the atmosphere around.

Some participants prefer to learn in class, while others prefer self study in the laboratory and library. Some participants liked the lecturer to explain the materia and others liked independent study and several others liked study groups. Some participants enjoy learning using printed teaching materials, some liked the electronic teaching materials. However, most participants liked material in the form of an animated video with a duration of 3-5 minutes.

Other findings included learners prefer to work and collect duties at night compared with during the day. This is become during the day there are many activities on campus and some are active in student organisations.

### 3. Learning innovation with video learning materials

The first test activity (alpha testing) is done to get feedback and response from the validator to the products developed. In phase 1 validator provide input for product improvement materials. However validator only provides feedback for improvement of language. As for some advice and input at this stage of the first test are: 1) the consistency of the term model used on all products developed, 2) the use of appropriate language and spelling is enhanced, 3) design of the display is made neater and more attractive to users, 4) use ISDB UM logo and logo on all products.

### 4. Revised Product

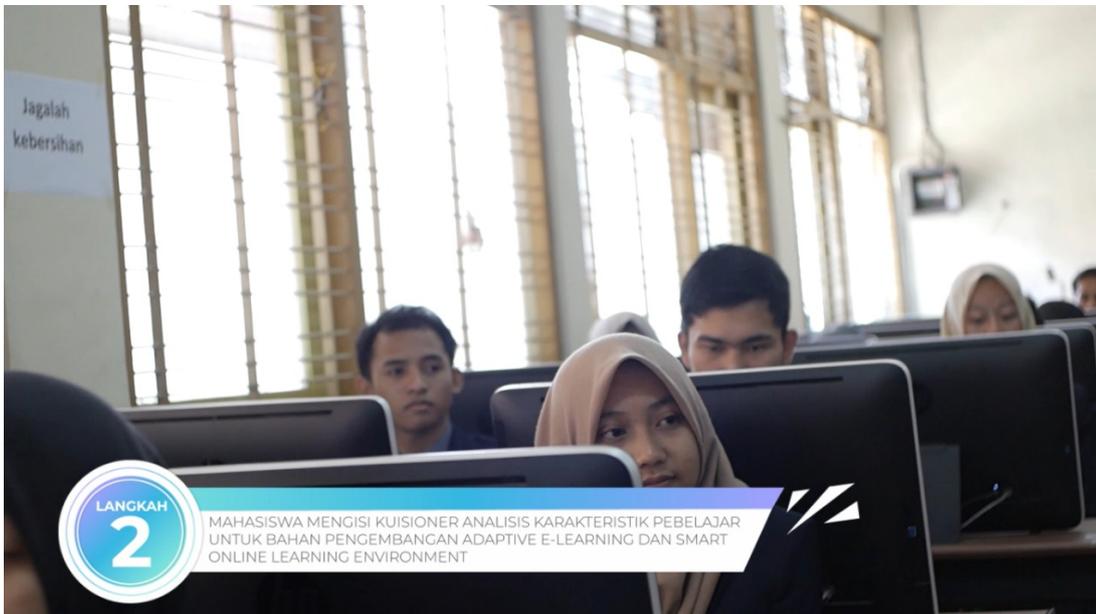
Revised product at this stage is the process of product improvement to the recommendation from the validator in the first test. Revisions were made on the products developed according to the suggestions of the validator placing emphasis on 1) the consistency of the term model used on all products developed, 2) the use of appropriate language and enhacing spelling, 3) design of the display is made neater and more attractive to users, 4) use of the UM logo and ISDB logo on all products.

### 5. Second Test Results

The meaning of the second test on product development is the process of testing the limited class. Thus providing input and advice on the products developed by the students. Not much information can be presented in this section since the implementation process is still running the temporary models developed in the 11th week of the study.

Data about the response and assessment of usability, usefulness, ease of operating, the carrying capacity of learning, will be complete by week 16 of the study. Thus in this second test results,

we will be delivering some of the statements the students as we show in the video implementation (Figure 5).



*Fig 5. Students activities fill out an application form online for Model Alams*

## 6. Product Enhancements

Get feedback from users on the second phase of testing will enhance Alams product. Alams product enhancements done on the components include 1) improvement in the product as Alams models are still not complete and detailed, 2) improvement of the completeness of the online course on e-learning / SIPEJAR, because SIPEJAR could use 9 weeks of lectures, so that in the early- beginning of the term it is still using the e-learning platform, 3) improvement in learning video content, 4) improvement in application instrument as Alams primarily on project components end users of the products developed.

The results of the assessment of the users described as below

### 1. Curriculum Development Model (MPK) aspects

Online form filling data in Alams product ratings range from 12 respondents from offering class A, B, and C. Class A offering that fill the online form 33.3% votes ie 4 respondents in offering class B as 6 respondents or 50% and class offering C by 2 respondents 16.7%.

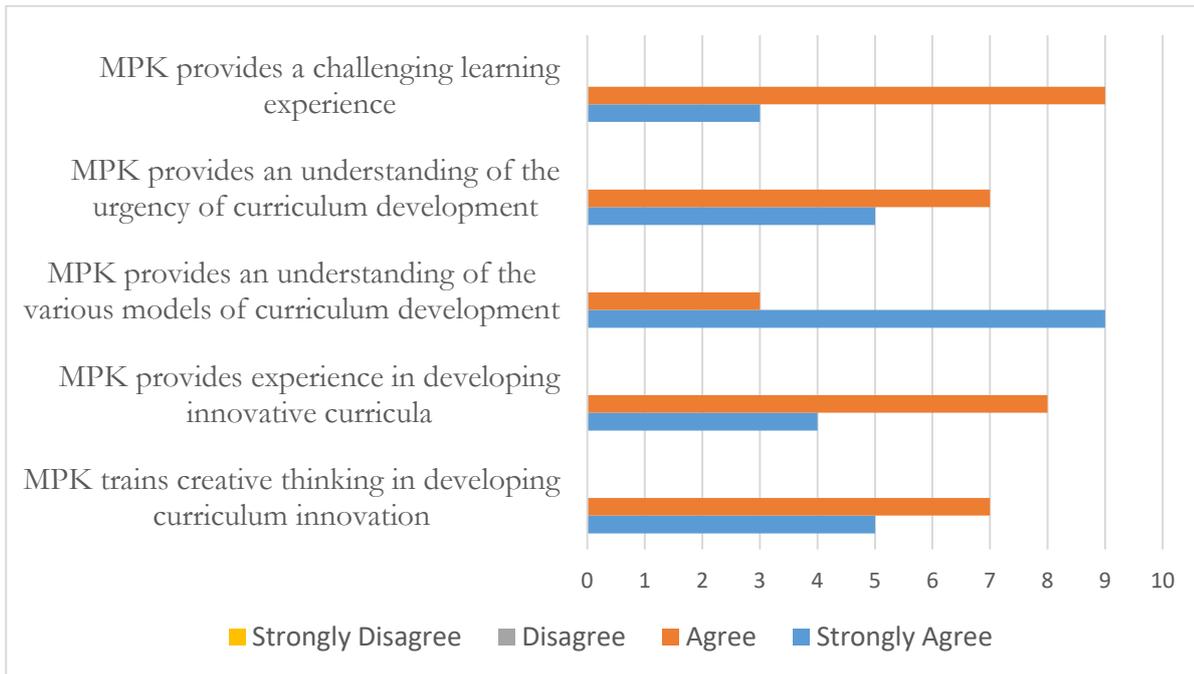


Fig 5 Data lectures aspect of Curriculum Development Model (MPK)

The Class of Curriculum Development Model (MPK) generally provide challenging learning experience with 12 respondents who fill out the form online (Figure 6). There were as many as 9 respondents with the percentage 75% and as many as 3 respondents strongly agreed with a percentage of 25%. Class Model Curriculum Development provides an understanding of the urgency of curriculum development with the presentation and as many as 7 respondents with a percentage of 58.3%, which was agreed by 5 respondents with a percentage of 41.7%. MPK lecture provides an understanding of some of the models of curriculum development and the response could not agree as 9 respondents agreed with a percentage of 75%. Lectures MPK provides an innovative curriculum development experience and 8 respondents agreed with a percentage of 25%.

## 2. Blended learning aspects

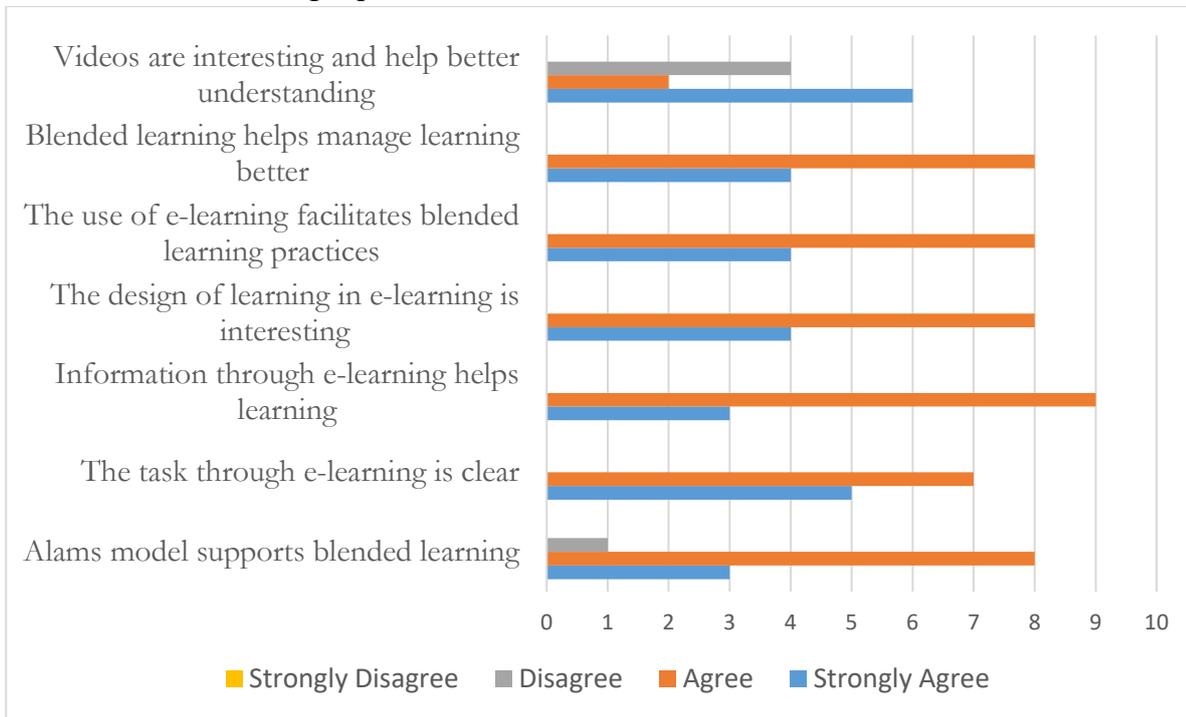


Fig 6 Data aspects of inter-face Blended Class and E-Learning

In the aspect of inter-face lectures blended and e-learning, helping a good learning management, respondents who agree were as many as 8 people with a percentage of 66.7% and the respondents strongly agree were with a percentage of 33.3%. In the use of e-learning facilitating blended learning practices, as many as 63.6% of respondents agree and strongly agree at 36.4%. It has been suggested that using e-learning can facilitate the cult of blended learning. Respondents considered that the design of the learning in e-learning is interesting. Respondents agreed to as much as 63.6% and 36.4% strongly agreed. User or respondents agreed that the information presented in e-learning can help the learning for students by the number of respondents who agree as much as 72.7% and 27.3% strongly agree. The tasks are delivered via e-learning are easy to understand with respondents who agree as much as 54.5%, and 45.5% strongly agree. This means that the tasks and information delivered via e-learning can be easily understood and can assist student learning (Figure 7).

Video learning material that is interesting to learn is strongly agree by as many as 6 respondents with a percentage of 50%, agreed with as many as 2 respondents with a percentage of 16.7%, and respondents did not agree with a percentage of 33.3%. Media videos can petrify understanding of student learning. Respondents who disagreed with the video media with as much data as three respondents with a percentage of 27.3%, respondents agree as much as 4 with 33.3% and the percentage of respondents who strongly agree was as many as 5 with a percentage of 41.7%. So based on the chart above the model Alams can support blended learning with the number of respondents agreeing as much as 63.6%, strongly agreeing as much as 27.3%, and disagreeing with

9.1%. Respondents strongly agreed with the analysis at the beginning of the lecture as much as 63.6% and agreed as much as 36.4%.

### 3. Learner analysis aspects

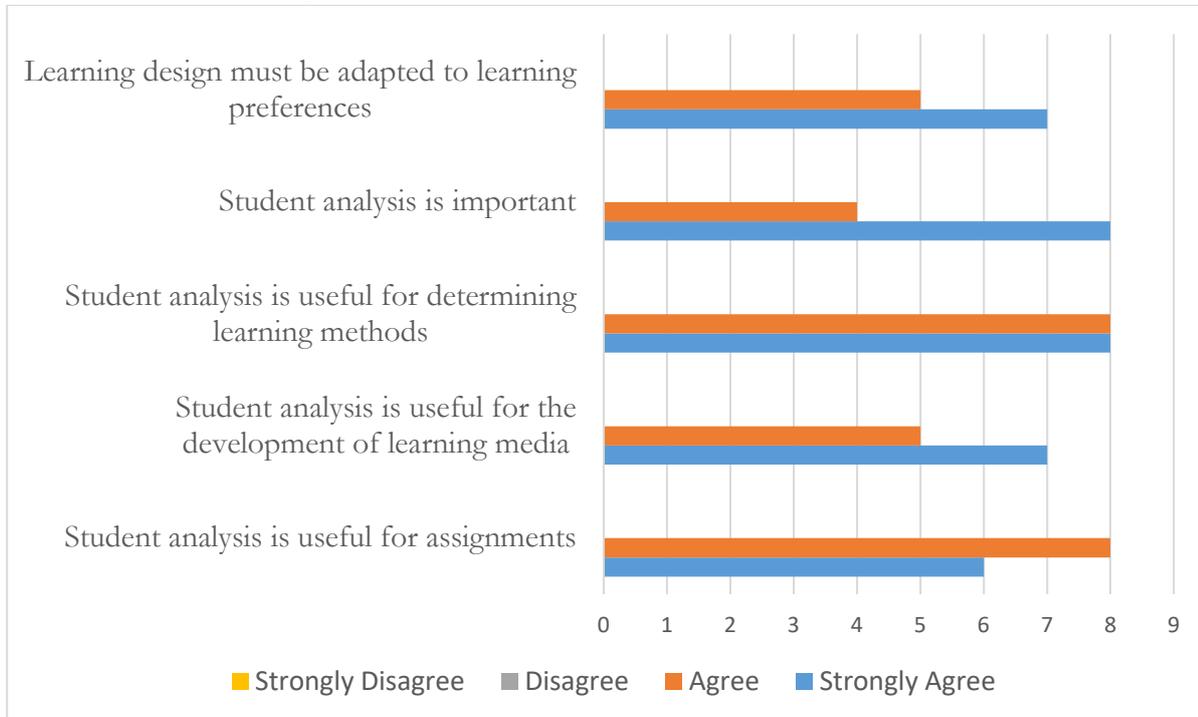


Fig 7 Data respons of learner analysis aspects

In the aspect of learner analysis and program design lecturing should match the characteristics of the respondents strongly agreed with as much as 63.6%, equivalent to 36.4% of respondents agreed. Results of analysis are useful for determining learning methods and respondents strongly agree as much as 54.5% and agreed as much as 45.5%. Results of analysis are useful for the development of learners learning media and respondents strongly agree as many as 54.5% and agreed as much as 45.5%. This means that the results of the analysis of learners can be useful for the determination of the method of learning and development of instructional media (Figure 8).

Learner assessment data analysis results are useful for the determination of the assignment to students and respondents strongly agree as much as 54.5% and as much as 45.5% agreed. Alams models can give an idea of the difference for student learning preferences, with the number of respondents who agree as much as 63.6% and respondents who strongly agreed were as much as 27.3% and there are those who disagree with 9.1%. From this data it is known that the beneficial learners for the determination of the assignment to students and Alams models can provide a picture of the difference in learning for students learning preferences.

#### 4. Alams Model Aspects

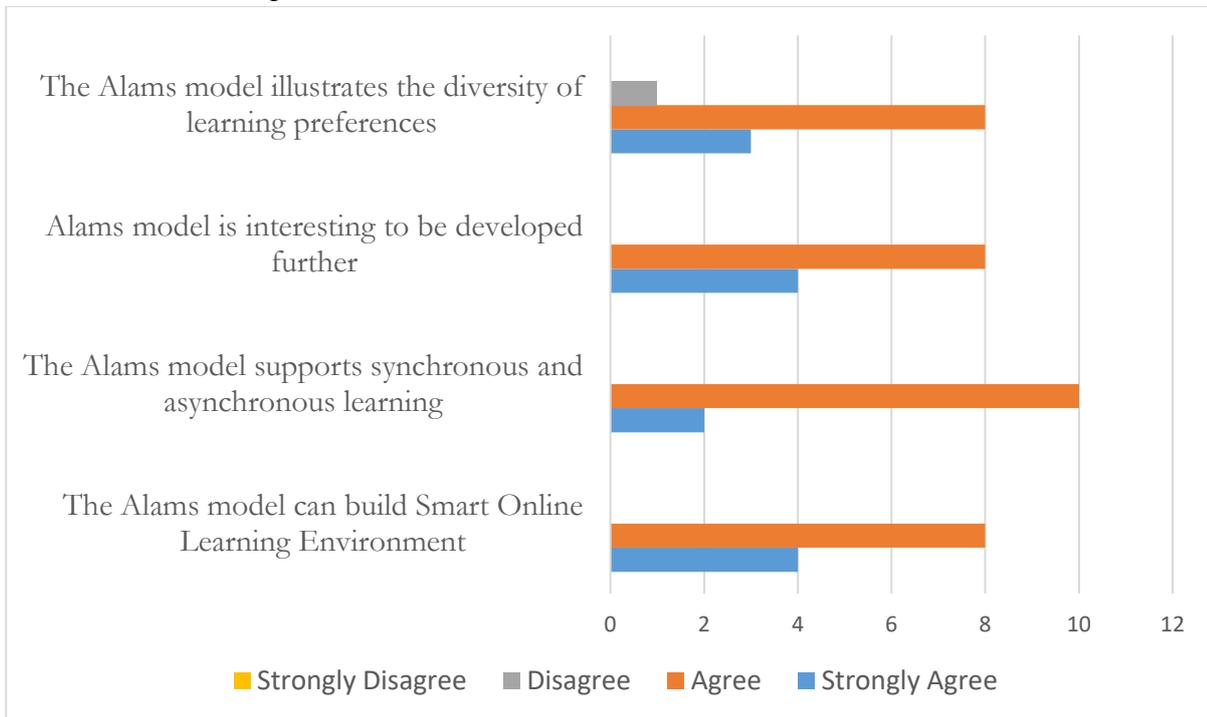


Fig 8 Responden opinions about Alams Model

Alams Model can develop further on a broader content learning that will allow the learning process in synchronous and asynchronous. Alams models can be developed to build Smart Online Learning Environment (SOLE) (Dietz-Uhler & Hurn, 2013; Ding, Xiong, & Liu, 2015; Hammad & Ludlow, 2016; Murthy, Iyer, & Mavinkurve, 2016; Robeck, Raghunathan, Singh, & Sharma, 2019). Data of the respondents as seen in Figure 9 who agreed with the Model Alams to develop more attractive and can be developed to build synchronous and asynchronous manner by 83% and 17% who strongly agree. In the poll of statement Alams model can be developed to build Smart Online Learning Environment (SOLE) (Hammad & Ludlow, 2016), respondents who agree as many as 8 or 67%. While respondents who strongly agree were as many as 4 people or 33%. Alams model attractive for development and respondents agree and 67% strongly agreed that as much as 33%. Later in the statement Alams Model provides an overview of differences in students' learning preferences, and respondents who do not agree were 8%, 67% agreed and strongly agreed that as much as 25%.

## DISCUSSION

Adaptive Learning Analytics Management System (Alams) is able to facilitate learning in a variety of different learning characteristics to be developed in the Learning Management System (SIPEJAR UM). Because the platform is still at the UM SIPEJAR, in the course of Curriculum Development Model was developed in it.

This view shows the viewing platform Alams is a developing curriculum development model. Simply put, learning innovations in the form of blended learning models between classical and



online learning in e-learning platform or SIPEJAR UM (Putra, Sulton, & Soepriyanto, 2019; Qonita, Sulton, & Soepriyanto, 2019). The fundamental innovation lies in the development of adaptive platform to the characteristics of learners. In practice, all students will be engaged in learning classical and synchronous and asynchronous online (Hirumi, 2006; Koper, 2003; Moore & Kearsley, 2011).

Learning Analytic is a new way to learn authentically how people learn, how a person involved in the learning process, how a person active in online discussion forums, how one accesses the material presented, how people listen enthusiastically, how does one do a good job, how does one collect assignments in a timely manner, how a person active in providing suggestions for improvements to the jobs done by his friend (Chatti, Dyckhoff, Schroeder, & Thüs, 2012; Elias, 2011b, 2011a; Park & Jo, 2015). Learning analytics is useful for lecturers to monitor the learning progress of students (Few, 2013), (Mainemelis et al., 2002), (Siemens, 2013). Likewise it can be beneficial for students to reflect on the level of participation, punctuality in collecting duties, the level of participation in online activities and others.

Learning in the digital age needs to integrate all learning components (Surahman, 2019). Integration of learning components can include components of objectives, content, strategies, evaluation and learning resources (Butcher, 2015; Koper, 2003; Lotrecchiano et al., 2013). Another form of integration is the traditional and digital learning resources (Ally & Samaka, 2013; Davis, Cochran, Fagerheim, & Thoms, 2016; Kaufman et al., 2017). This can increase the effectiveness of the process and learning outcomes (Shyshkina, 2018). Both educators and students can conduct learning activities optimally.

## CONCLUSION

Adaptive Analytic learning management system (Alams) is an innovative approach to online learning in the digital age. Models developed Alams declared valid and feasible based on results of expert assessment of learning and online learning media. Presentation of data on the analysis of learning can provide an overview of the four achievements and increase the participation of learners. In practice the analysis features in Alams models provide new experiences for learners. Grain material facilitates students to learn appropriate learning preferences. Based on the measurement of learning outcomes that can be obtained from the data a significant increase in learning outcomes.

The result of this research is still not perfect and needs some revision on some parts. Subsequent researchers need to develop learning Analytic features integrated with the LMS. This can only be done by a researcher who is also the main admin platform used. The teacher's role can not perform such a process. Also researchers need to conduct a trial in a class or subject that is more likely to get a better picture of the data.



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## REFERENCES

- Akbar, T. N. (2016). Pengembangan Multimedia Interaktif IPA Berorientasi Guided Inquiry pada Materi Sistem Pernapasan Manusia Kelas V SDN Kebonsari 3 Malang. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, 1(6), 1120–1126.
- Ally, M., & Samaka, M. (2013). Open education resources and mobile technology to narrow the learning divide. *The International Review of Research in Open and Distributed Learning*, 14(2), 14–27.
- Bower, G. G. (2013). Utilizing Kolb's Experiential Learning Theory to Implement a Golf Scramble. *International Journal of Sport Management, Recreation & Tourism*, 12.
- Bralić, A., & Divjak, B. (2018). Integrating MOOCs in traditionally taught courses: achieving learning outcomes with blended learning. *International Journal of Educational Technology in Higher Education*, 15(1). <https://doi.org/10.1186/s41239-017-0085-7>
- Butcher, N. (2015). *A basic guide to open educational resources (OER)*. Commonwealth of Learning (COL);
- Chatti, M. A., Dyckhoff, A. L., Schroeder, U., & Thüs, H. (2012). Forschungsfeld Learning Analytics. *I-Com*, 11(1), 22–25.
- Davis, E., Cochran, D., Fagerheim, B., & Thoms, B. (2016). Enhancing teaching and learning: Libraries and open educational resources in the classroom. *Public Services Quarterly*, 12(1), 22–35.
- Dietz-Uhler, B., & Hurn, J. E. (2013). Using learning analytics to predict (and improve) student success: A faculty perspective. *Journal of Interactive Online Learning*, 12(1), 17–26.
- Ding, J., Xiong, C., & Liu, H. (2015). Construction of a digital learning environment based on cloud computing. *British Journal of Educational Technology*, 46(6), 1367–1377.
- Elias, T. (2011a). Learning analytics. *Learning*, 1–22.
- Elias, T. (2011b). Principles for Mobile Learning. *The International Review of Research in Open and Distributed Learning*. <https://doi.org/10.1007/978-1-4419-0585-7>
- Few, S. (2013). *Information Dashboard Design: Displaying data for at-a-glance monitoring* (Vol. 5). Analytics Press Burlingame, CA.
- Gardner, H. (1992). *Multiple intelligences* (Vol. 5). Minnesota Center for Arts Education.
- Gašević, D., Dawson, S., & Siemens, G. (2015). Let's not forget: Learning analytics are about learning. *TechTrends*, 59(1), 64–71.
- Hammad, R., & Ludlow, D. (2016). Towards a smart learning environment for smart city governance. *Proceedings of the 9th International Conference on Utility and Cloud Computing*, 185–190. ACM.
- Hirumi, A. (2006). Analysing and designing e-learning interactions. In *Interactions in online education* (pp. 60–85). Routledge.
- Kaufman, J. H., Davis, J. S., Wang, E. L., Thompson, L. E., Pane, J. D., Pfrommer, K., & Harris, M. (2017). Use of open educational resources in an era of common standards. *RAND Corporation*, March, 27.
- Kemp, J. E., Dayton, D. K., & Kemp, J. E. (1985). *Planning and producing instructional media*. Harper & Row.
- Koper, R. (2003). Combining reusable learning resources and services with pedagogical purposeful

- units of learning. In *Reusing online resources* (pp. 64–77). Routledge.
- Lee, W. W., & Owens, D. L. (2004). *Multimedia-based instructional design: computer-based training, web-based training, distance broadcast training, performance-based solutions*. John Wiley & Sons.
- Lim, L., Dawson, S., Joksimovic, S., & Gašević, D. (2019). Exploring students' sensemaking of learning analytics dashboards: Does frame of reference make a difference? *Proceedings of the 9th International Conference on Learning Analytics & Knowledge*, 250–259. ACM.
- Lotrecchiano, G. R., McDonald, P. L., Lyons, L., Long, T., & Zajicek-Farber, M. (2013). Blended learning: strengths, challenges, and lessons learned in an interprofessional training program. *Maternal and Child Health Journal*, 17(9), 1725–1734.
- Mainemelis, C., Boyatzis, R. E., & Kolb, D. A. (2002). Learning Styles and Adaptive Flexibility: Testing Experiential Learning Theory. *Management Learning*. <https://doi.org/10.1177/1350507602331001>
- Moore, M. G., & Kearsley, G. (2011). *Distance education: A systems view of online learning*. Cengage Learning.
- Moreno, R., & Mayer, R. E. (2000). A learner-centered approach to multimedia explanations: Deriving instructional design principles from cognitive theory. *Interactive Multimedia Electronic Journal of Computer-Enhanced Learning*, 2(2), 12–20.
- Murthy, S., Iyer, S., & Mavinkurve, M. (2016). Pedagogical framework for developing thinking skills using smart learning environments. *Learning, Design, and Technology: An International Compendium of Theory, Research, Practice, and Policy*, 1–49.
- Olmos, M. M., & Corrin, L. (2012). *Learning analytics: A case study of the process of design of visualizations*.
- Park, Y., & Jo, I.-H. (2015). Development of the learning analytics dashboard to support students' learning performance. *Journal of Universal Computer Science*, 21(1), 110.
- Prastiti, S. D., & Pujiningsih, S. (2009). Pengaruh faktor preferensi gaya belajar terhadap prestasi belajar mahasiswa akuntansi. *Jurnal Ekonomi Bisnis*, 14(3), 20–35.
- Putra, B. T., Sulton, S., & Soepriyanto, Y. (2019). Pengembangan Screencast sebagai Electronic Performance Support System dalam Pemanfaatan Sipejar UM. *Jurnal Kajian Teknologi ...*. Retrieved from <http://journal2.um.ac.id/index.php/jktp/article/view/252>
- Qonita, A., Sulton, S., & Soepriyanto, Y. (2019). Persepsi Kegunaan, Persepsi Kemudahan Dan Aksesibilitas Mahasiswa Fakultas Ilmu Pendidikan Angkatan 2018 Terhadap Penerapan Sipejar Menggunakan Model TAM (Technology Acceptance Model). *Jurnal Kajian Teknologi Pendidikan*, pp. 140–148. <https://doi.org/10.17977/um038v2i22019p140>
- Robeck, E., Raghunathan, S., Singh, A. D., & Sharma, B. (2019). Diverse Applications of the Elements of Smart Learning Environments. In *Cases on Smart Learning Environments* (pp. 118–141). IGI Global.
- Shyshkina, M. (2018). The hybrid service model of electronic resources access in the cloud-based learning environment. *ArXiv Preprint ArXiv:1807.09264*.
- Siemens, G. (2013). Learning analytics: The emergence of a discipline. *American Behavioral Scientist*, 57(10), 1380–1400.
- Smaldino, E. (2012). Instructional Technology and Media for Learning Teknologi Pembelajaran



dan Media untuk Belajar, terj. Arif Rahman, Jakarta: Kencana.

- Surahman, E. (2019). Integrated Mobile Learning System (IMOLES) sebagai Upaya Mewujudkan Masyarakat Pebelajar Unggul Era Digital. *JINOTEP (Jurnal Inovasi Dan Teknologi Pembelajaran) Kajian Dan Riset Dalam Teknologi Pembelajaran*, 5(2), 50–56.
- Surahman, E., & Surjono, H. D. (2017). Pengembangan adaptive mobile learning pada mata pelajaran biologi SMA sebagai upaya mendukung proses blended learning. *Jurnal Inovasi Teknologi Pendidikan*, 4(1), 26–37. <https://doi.org/10.21831/jitp.v4i1.9723>
- Surjono, H. D. (2011). The design of adaptive e-learning system based on student's learning styles. *International Journal of Computer Science and Information Technologies*, 5(2), 2350–2353.
- Temitope Favour Jiboye, G. O. S. O. O. A. D. O. A. (2019). Mental ability, Self-esteem and Learning Styles as Correlate of Creativity among High Achieving Secondary School Students in Oyo State. *International Journal of Innovation, Creativity and Change*, 4(4), 24–43.
- Tumbel, F. M. (2018). Development of audio visual learning media using mitochondrial DNA analysis of fruit fly from minahasa based saintific approach. *Development*, 3(2).
- Verbert, K., Duval, E., Klerkx, J., Govaerts, S., & Santos, J. L. (2013). Learning analytics dashboard applications. *American Behavioral Scientist*, 57(10), 1500–1509.
- Ziaurrahman, Z., & Surjono, H. D. (2018). Pengembangan e-learning adaptif pada mata pelajaran Pendidikan Agama Islam untuk kelas X SMA. *Jurnal Inovasi Teknologi Pendidikan*, Vol. 4, p. 119. <https://doi.org/10.21831/jitp.v4i2.10458>