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The impact of learning management system implementation on students' understanding of mechanics concepts

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Abstract. The Learning management system (LMS) is an effective model of learning for solving the teaching problems. Effective learning will help students achieve better understanding of the concept. This article discusses the use of LMS in teaching mechanics and its effect on student understanding. This quasi-experiment research used one group post-test design. The sample used was 21 students from one of the higher educations in Mataram, Indonesia. The instrument used was the conceptual understanding test in multiple choices. The test consists of 30 questions which are divided into three mechanics concepts, namely Newton's Laws of Motion, Work and Energy, and Simple Harmonic Motion. Each data was analyzed using simple statistics. The findings showed that the use of LMS had a positive impact on students' understanding of each topic of mechanics concepts. The highest average score on the topic of Work and Energy. The lowest average score is on Newton's Laws of Motion. LMS is an alternative platform for developing students' understanding of concepts in each cognitive aspect.

1. Introduction

The Industrial Revolution 4.0 is characterized as a new level of management and control over the whole product life-cycle chain, including the Internet of Things, the Manufacturing Internet, and smart information and systems. Industry 4.0 is concerned with the tight integration of people into the development process in such a way that it continues to develop and concentrate on activities that are more productive and competitive [1]. The need for era 4.0 is to transform ordinary machines into machines that work independently to improve the performance of the entire system with interactions around it [2]. In terms of technological developments and socio-economic effects, development in the inherent diffusion of technology is projected to increase exponentially. So overcoming such transitions takes a holistic approach involving creative, sustainable system solutions and not just technical solutions [3]. Industry Revolution 4.0 is very closely linked to innovation to create new concepts that are more competitive [4].

Higher education in the fourth industrial revolution must be open, rational, and provide energy that could change society to improve the quality of education today [5]. Technological advancements in this age continue to change teaching methods and to regulate the learning process. Changes that have taken place in this era show that the learning preferences of the current generation must be close to technology. Education must adapt to the changes brought about by the 4.0 Industrial Revolution. It is time for class instructors to consider and integrate more technology into their teaching methods [6]. Education focuses



more on the development of the quality of human life, both as individuals and as social beings, and is geared towards the development of technology itself.

The development of technology indirectly changes the perspective of education. The shift in education today is not just a concept of teaching, but it is far more essential, namely a change in perspective on the concept of education itself [7]. Education 4.0 is considered an opportunity for educational institutions that are ready to grow their students' readiness to enter a new round of the world of education that is changing so fast. Puncreobutr [8] revealed that students are required to be more creative and innovative in compensating for the changes that occur.

Teachers/lecturers as one of the main components in the world of education must be able to develop their competence in facing the 4.0 era. The teacher/lecturer must be rich in ideas to present interesting learning, can collaborate and communicate [9]. Also, teachers must not only be able to change the way of thinking of students facing all the barriers they experience but must be able to respond to the changing needs of students and adapt to the rapid development of technology. Teachers are also needed at this time to facilitate learning by providing technology-based learning resources. Therefore, to respond to the problems of this period, improving the standard of education also has to be done.

The first thing that needs to be done in the modern phase of education is to train students to understand the idea well enough that it can be applied to daily life. Students must be able to interpret the theory and its application scientifically and be able to develop the science themselves [10]. Efforts must be made to master the concept of recording and transferring back the information from a subject matter [11]. Dimensions of cognitive outcomes to measure the mastery of these concepts are: remember, understand, apply, analyze, evaluate, and create [12]. Cognitive ability is important for students because it illustrates the mastery of students' concepts of the material being taught [13].

Students' understanding can also provide information on how students absorb, master, and store the material learned in the long term. Learning mechanics concept in higher education, students must master the concepts well. The concepts of mechanics are very difficult for students to understand [14]. The learning mechanics concept must use the right strategy so that the results are also more effective. One effective learning device that supports the development of the current era is a learning device based on technology.

One innovative learning device-oriented to information technology is the Learning Management System (LMS). LMS is a method of learning that makes use of information technology in learning. LMS features that are designed as e-learning systems can be developed for social activities and assessments. Users such as students, lecturers, and administrators can manage schedules, work, discussions, lectures, and even research [15]. In higher education, the learning process applied by LMS can optimally manage learning thereby increasing effectiveness in the process [16]. In the process, LMS is used as an approach that can improve learning achievement [17] and efficiently used in learning [18] so that it can improve students' conceptual abilities [19]. The success of the LMS as a learning environment can encourage an increase in learning needs and student participation, to realize the expected goals [20].

Learning models that can support the use of LMS are blended learning models. Some exploratory studies about the use of blended learning provide valuable experiences for students. The use of complementary tools enables an effective learning process. Most students very well accept the use of blended learning. Many students note that accessing various sources through LMS on blended learning is very useful [21]. Blended learning is useful and effective for face-to-face and online learning. This study provides learning that is comprehensive and comparable to the needs of students [22]. Blended learning with LMS supports achievement. Cognitive abilities are found to have a positive relationship with an online performance that is applied in blended learning [23]. Based on the description above, this article discusses the results of LMS implementation in learning mechanics concept towards students' understanding. The use of LMS in learning is applied in the blended learning model.

2. Method

This study is part of research and development. The LMS tool in the blended model has been developed and is declared valid to be used by expert validators. At the testing stage, this quasi-experimental study

was conducted at one of the higher education in Mataram, Indonesia, with a posttest group design. The sample was selected using a purposive sampling technique, with a total sample of 21 students. Samples were treated in the form of using LMS as an e-learning system in the blended model. The conceptual understanding data of the students was collected from 30 multiple choice instruments that were checked by experts for validity. The test instrument consisted of three topics of mechanics namely Newton's Law of Motion, Work and Energy, and Simple Harmonic Motion. The problem is spread in six cognitive aspects. Six cognitive aspects are involved in the problem, namely C1 (remembering), C2 (understanding), C3 (applying), C4 (analyzing), C5 (evaluating), and C6 (creating). The comparison of students' understanding in each topic is done with a simple analysis based on the average score. The number of students' correct answers on each cognitive aspect is also analyzed.

3. Results and Discussion

Students' understanding as concept mastery includes the ability to remember, understand, apply, analyze, evaluate, and create various related concepts [24]. Good mastery of physical concepts will influence the development of thinking skills well [25]. In this study, the blended learning model is used to promote the students' understanding of the mechanics concept. Multiple choice instruments are used to measure students' understanding. The results showed that in each topic of mechanics concepts, there were differences in the results of the students' understanding tests. The comparison of the acquisition of students' understanding test results is shown in Figure 1. below.

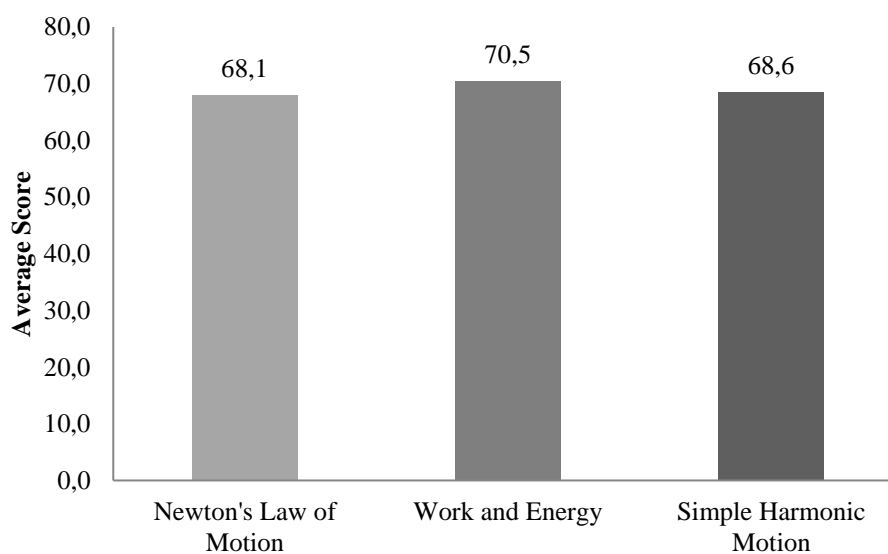


Figure 1. The Differences in Average Students' Understanding Scores in Each Topic of Mechanics Concepts

Based on Figure 1., there were differences in the average students' understanding score of the mechanics concept after learning. The highest score is in the concept of Work and Energy, then Simple Harmonic Motion. The lowest average score is concept of Newton's Law of Motion. Students can answer questions well on concept Work and Energy because the questions presented fall into the category of easy and medium questions. Whereas in Newton's Law of Motion, there are several questions with high cognitive domains such as C5 and C6 so that some students have not been able to answer properly. In the Simple Harmonic Motion topic, there was one problem with the C6 cognitive domain which is classified as a difficult problem. In this question, only three students were able to answer correctly. The difference in scores is not substantially different for each topic. The average score of students in each topic showed that there was a score gap that is not too far away. Students were quite able to solve the problem of concepts in all topics well.

On the topic of Newton's Law of Motion, students construct concepts through several worksheets. Worksheets help students understand the concept of applying Newton's law in everyday life, analyze diagrams of forces acting on a system of motion and even describe their equations. Primanda et al. [26] revealed that the use of worksheets in learning Newton's Law of Motion is effective and practical to improve students' conceptual understanding and problem-solving of physics. Also, the use of virtual laboratories at Newton's Law of Motion learning can present the components of the force acting on the motion system to realize a better understanding of the concept. Thornton & Sokoloff [27] stated that the use of computer-based laboratories in learning Newton's Law supports active learning to improve learning outcomes. Learning about the topic of Simple Harmonic Motion through the use of technology also has a positive impact on cognitive aspects [28]. The LMS provides an explanation of the concepts, equations, and physical phenomena related to simple harmonic motion. Likewise with the topic of Work and Energy, the worksheets used during the lesson train students to solve problems based on the concepts presented. During learning, students are also used to solving mathematical problems by describing or compiling equations to realize a better understanding of the concept. The concept of Work and Energy has become part of students' daily experiences [29] so that good learning will result in a good increase in achievement as well [30].

The developed LMS contains content of teaching material that can be easily accessed by students. Students can access the teaching material online at anytime and anywhere. Students can learn the concepts presented and work on the exercises that are available in teaching materials. This certainly supports the development of students' understanding of mechanics concepts. The same thing was revealed by Hill et al. [31] that the use of online learning resources such as e-modules can be used to support conceptual understanding and scientific representation.

At the exploration stage in the syntax of blended learning, students carry out problem-solving activities through virtual experiments then complete the worksheets provided. Virtual experiments carried out are about the concept of Newton's Law, the Law of Conservation of Mechanical Energy, and Harmonic Motion on a Simple Pendulum. Through virtual experiments, students' understanding of mechanics concepts can be well facilitated. In addition to the worksheets presented, it also trains students to understand the concepts with a high cognitive domain. This is indicated on the worksheets, students must complete the questions related to virtual experiments. Students can repeatedly experiment, and even envision abstract ideas that cannot be seen or imagined in a real laboratory. Virtual experiments can improve the understanding of concepts in all cognitive aspects [32].

The students' understanding of mechanics concepts test results were also assessed based on the number of correct students' answers on each cognitive aspect. This is intended to determine the degree of students' conceptual understanding achieved. Figure 2 below showed the percentage comparison of the students' correct answers on each cognitive aspect.

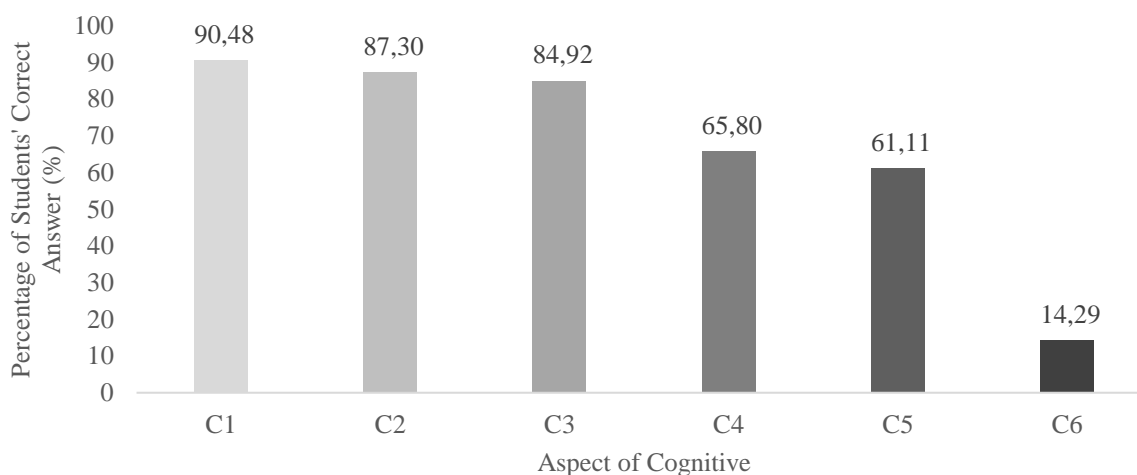


Figure 2. Percentage of Students' Correct Answers on Each Cognitive Aspect

Based on the data in Figure 2 there are differences in the percentage of the average score of students towards the acquisition of answers on each cognitive aspect. Most students can answer questions C1, C2, and C3 very well. In cognitive aspects, C4 and C5 begin to decrease. But the decline that occurred was not too significant. More than 50% of the students can answer the question correctly. The problem in the cognitive aspect of the C6 score has the lowest score. Most students have not been able to create the concept of mechanics well. In the C6 question, students must consider a particular circumstance, principles, ideas, or approaches based on current requirements and standards. Cognitive processes included in C6 are to be interpreted, produced, combined, reconstructed, and criticized.

In the case of C6, students were required to render and merge many components into a form of unity. This cognitive aspect of C6 brings many components together to construct and organize a rational and functional whole into new patterns or structures. Therefore, a high level of thinking ability is needed very well to master this cognitive aspect of C6. Analysis of the percentage of students in each cognitive aspect that has been presented showed that the ability of students in answering the questions is better in lower cognitive aspects, and conversely weaker in higher cognitive aspects. This finding is in line with research by Gunawan et al. [32] that the computer simulation used in learning can enhance the mastery of concepts in the realm of C1 to C4. Meanwhile, aspects of C5 and C6 need to be developed through a variety of exercises. The practice questions in the form of e-assessment were also presented in this study. In the reflection stage in the syntax of blended learning, students do self-reflection by practicing answering the questions given. Besides, students can easily access the practice questions in the form of an e-assessment on LMS. This caused when the final exam, students can properly solve the problem mastery of concepts. Sahidu et al. [33] also revealed that the use of e-assessment can increase student motivation to guide students in solving problems well.

The use of LMS in learning successfully adds to motivating students to learn so that they have a better understanding of concepts. The LMS implemented in the blended model is known to help the conceptual understanding of the students on mechanical concepts. The same thing was expressed by Herayanti et al. [34] that the used of Moodle LMS in blended learning can enhance students' understanding of concepts in wave concepts. The environment in blended learning is flexible and provides the social interaction needed for learning [35].

The results in this research were consistent with the findings of Gunawan et al. [36] which found that the more fascinating the learning media used, the students' motivation in learning increased so that students' understanding of physics concepts was also enhanced as well. Students' understanding of concepts embedded in students will help in solving questions and problems encountered during learning. There were virtual laboratory and instructional videos in the LMS that are used in media to express concepts. The media presented should be able to assist students in learning. Zacharia [37] also supports this result by revealing that the use of computer systems such as virtual laboratories can improve conceptual understanding. The use of computer systems in the form of virtual laboratories and animation can improve scientific skills on the concept of heat [38] and student creativity in learning physics [39]. Besides all the application of learning syntax in the blended model also supports the mastery of student concepts. Blended learning is a flexible approach that is used to improve high-level learning outcomes through e-learning such as conducting simulations, experiments, tutorials, and online assessments [40]. Students can explore abstract problems through online media and then analyze their solutions [41]. The LMS on the blended model also allows flexible learning, where students can choose when and where they access learning material [42].

4. Conclusion

The use of LMS in learning with a blended model helps students develop their conceptual understanding on mechanics concept. There were differences in the average score of the conceptual understanding score in each topic of the mechanics concept. The highest score is on the topic of Work and Energy, then Simple Harmonic Motion. The lowest average score of conceptual understanding of mechanics concepts is Newton's Law of Motion topic. Analysis of the percentage of the correct answers of students in each cognitive aspect showed that the ability of students in answering questions of conceptual

understanding is better in lower cognitive aspects and conversely decreased in higher cognitive aspects. This is because the problems in the high cognitive aspect are classified as difficult questions. In general, the used of LMS with a blended model has a positive effect on students' conceptual understanding. Recommendations that can be given for further research are to introduce features available in the LMS before learning. Students must be introduced in advance with what content is developed and what components are accessible.

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The Impact of Learning Management System Implementation on Students' Understanding in Mechanics Concept

Gunawan¹, Ahmad Harjono², Ni Made Yeni Suranti³, Lovy Herayanti⁴, Imran⁵

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Commented [A1]: Should be "of the concepts of mechanics".

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Education must adapt to the changes brought about by the 4.0 Industrial Revolution. It is time for class instructors to consider and integrate more technology into their teaching methods [6]. Education focuses more on the development of the quality of human life, both as individuals and as social beings, and is geared towards the development of technology itself.

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2. Method

This study is part of research and development. The LMS tool in the blended model has been developed and is declared valid to be used by expert validators. At the stage of testing, this model is a quasi-experimental research with a posttest control group design conducted at one of the higher educations in the city of Mataram, Indonesia. The sample was selected using a purposive sampling technique, with a total sample of 21 students. Samples were treated in the form of using LMS as an e-learning system in the blended model. The students' conceptual understanding data were obtained from 30 multiple choice test instruments that had been tested for validity by experts. The test instrument consisted of three sub-topics of mechanics namely Newton's Law of Motion, Work and Energy, and Simple Harmonic Motion. The problem is spread in six cognitive aspects, namely C1 (remembering), C2 (understanding), C3 (applying), C4 (analyzing), C5 (evaluating), and C6 (creating). The comparison of mastery of concepts in each sub-topic is done with a simple analysis based on the average score of students' conceptual understanding. Also analyzed are the number of students' correct answers on each cognitive aspect

3. Results and Discussion

Students' understanding as concept mastery includes the ability to remember, understand, apply, analyze, evaluate, and create various related concepts [24]. Good mastery of physical concepts will influence the development of thinking skills well [25]. In this study, the blended learning model is used to promote the students' understanding of the mechanics concept. Multiple choice instruments are used to measure students' understanding. The results showed that there were differences in the results of the students' understanding tests in each sub-topic of mechanics. The comparison of the acquisition of students' understanding test results is shown in Figure 1 below.

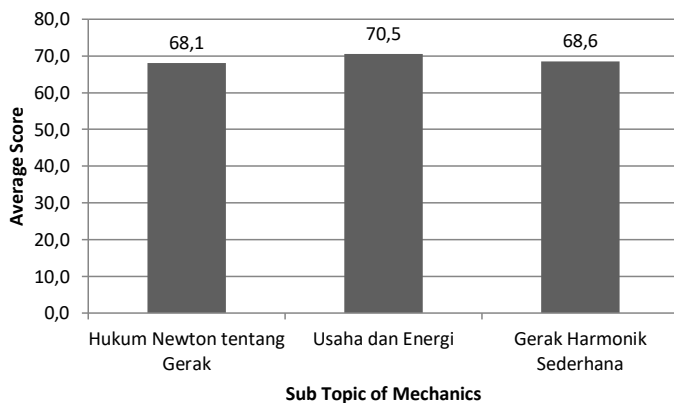


Figure 1. The Differences in Average Students' Understanding Scores in Each Mechanics Sub Topic

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 •Put theoretical explanation of the sub-concept at which students have better understanding on it. You may explain using the formula or something unique in the sub-concept.

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At the exploration stage in the syntax of blended learning, students carry out problem-solving activities through virtual experiments then complete the worksheets provided. Virtual experiments carried out are about the concept of Newton's Law, the Law of Conservation of Mechanical Energy, and Harmonic Motion on a Simple Pendulum. Through virtual experiments, students' understanding of mechanics concepts can be well facilitated. In addition to the worksheets presented, it also trains students to understand the concepts with a high cognitive domain. This is indicated on the worksheets, students must complete the questions related to virtual experiments. Students can experiment repeatedly and also visualize abstract concepts that are not possible to see or imagine in a real laboratory. Virtual experiments can improve students' understanding of concepts in all cognitive aspects [27].

The students' understanding of mechanics concepts test results were also analyzed based on the number of students' correct answers on each cognitive aspect. This is intended to determine the level of students' conceptual understanding gained. Figure 2 below showed the percentage comparison of the number of correct answers to students on each cognitive aspect.

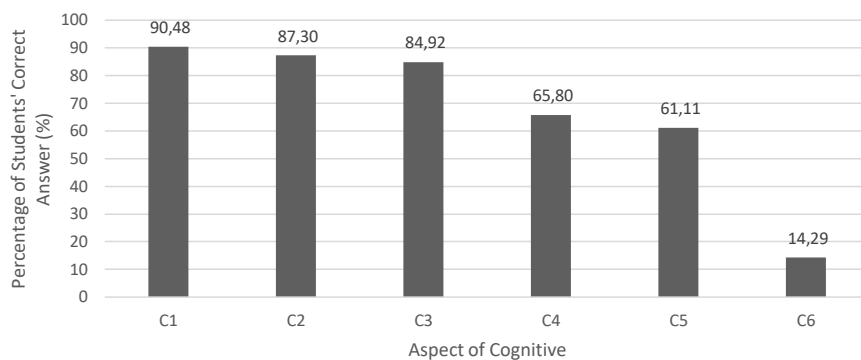


Figure 2. Percentage of Students' Correct Answers on Each Cognitive Aspect

Based on the data in Figure 2 there are differences in the percentage of the average score of students towards the acquisition of answers on each cognitive aspect. Most students can answer questions C1, C2, and C3 very well. In cognitive aspects, C4 and C5 begin to decrease. But the decline that occurred was not too significant. More than 50% of the students can answer the question correctly. The problem in the cognitive aspect of the C6 score has the lowest score. Most students have not been able to create the concept of mechanics well. In the question of C6, students are required to consider a specific situation, values, ideas or methods based on existing criteria and standards. Cognitive processes included in this category are to be interpreted, produced, combined, reconstructed and criticized.

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in this study. In the reflection stage in the syntax of blended learning, students do self-reflection by practicing answering the questions given. Besides, students can easily access the practice questions in the form of an e-assessment on LMS. This causes when the final exam, students can properly solve the problem mastery of concepts. Sahidu et al [28] also revealed that the use of e-assessment can increase student motivation to guide students in solving problems well.

The use of LMS in learning successfully adds to motivating students to learn so that they have a better understanding of concepts. LMS which is applied in the blended model is proven to be able to support students' conceptual understanding on mechanics concepts. The same thing was expressed by Herayanti et al [29] that the use of Moodle LMS in blended learning was able to improve students' understanding of concepts in wave material. The environment in blended learning is flexible and provides the social interaction needed for learning [30].

The findings in this study were in line with the research findings of Gunawan et al [31] which found that the more interesting the learning media used, the students' learning motivation increased so that students' understanding of physics concepts improved as well. Students' understanding of concepts embedded in students will help in solving questions and problems encountered during learning. There were virtual laboratory and instructional videos in the LMS that are used in media to express concepts. The media presented should be able to assist students in learning. Zacharia [32] also supports this result by revealing that the use of computer systems such as virtual laboratories can improve conceptual understanding. The use of computer systems in the form of virtual laboratories and animation can improve scientific skills on the concept of heat [33] and student creativity in learning physics [34]. Besides all the application of learning syntax in the blended model also supports the mastery of student concepts. Blended learning is a flexible approach that is used to improve high-level learning outcomes through e-learning such as conducting simulations, experiments, tutorials, and online assessments [35]. The LMS on the blended model also allows flexible learning, where students can choose when and where they access learning material [36].

4. Conclusion

The use of LMS in learning with a blended model helps students develop their conceptual understanding on mechanics concept. There were differences in the average score of the conceptual understanding score in each sub-topic of the mechanics concept. The highest score is in the topic of Work and Energy, then Simple Harmonic Motion. The lowest average score of conceptual understanding of mechanics concepts is Newton's Law of Motion topic. Analysis of the number of students in each cognitive aspect showed that the ability of students in answering questions of conceptual understanding is higher in lower cognitive aspects, and conversely weaker in higher cognitive aspects. This is because the problems in the high cognitive aspect are classified as difficult questions. In general, the use of LMS in the blended model has a positive impact on students' conceptual understanding. Recommendations that can be given for further research are to introduce features available in the LMS before learning. Students must be introduced in advance with what content is developed and what components are accessible.

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The Impact of Learning Management System Implementation on Students' Understanding in Mechanics Concept

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Abstract. The Learning management system is an effective model of learning for solving the teaching problems. Effective learning will help students get a good understanding of the concept. This article discusses the use of LMS in teaching mechanics and its effect on student understanding. The research was a quasi-experiment with one group post-test design. The sample used was 21 students from one of the higher educations in Mataram, Indonesia. The instrument used was the conceptual understanding in multiple choices. The test consists of 30 questions which are divided into three mechanics concepts, namely Newton's Laws of Motion, Work and Energy, and Simple Harmonic Motion. Each data was analyzed using simple statistics. The results indicated that the use of LMS had a positive effect on students' understanding of each subject of mechanics concepts. The highest average score is on the subject of Work and Energy. The lowest average score is on Newton's Laws of Motion. Learning Management System is an alternative platform for developing students' understanding of concepts in each cognitive aspect.

1. Introduction

The term Industrial Revolution 4.0 is defined as a new level of organization and control over the entire product life cycle chain, including the Internet of Things, the Industrial Internet, and smart knowledge and systems. Industry 4.0 is concerned with the tight integration of humans into the manufacturing process in such a way that it makes continuous improvements and focuses on activities that are more effective and efficient [1]. The need for era 4.0 is to transform ordinary machines into machines that work independently to improve the performance of the entire system with interactions around it [2]. Progress in inherent technological diffusion is expected to increase exponentially in terms of technical changes and socio-economic impacts. Thus, overcoming such transformations requires a holistic approach that includes innovative, sustainable system solutions, and not just technological solutions [3]. Industry Revolution 4.0 is very closely linked to innovation to create new concepts that are more competitive [4].

Higher education in the fourth industrial revolution must be open, rational, and provide energy that could change society to improve the quality of education today [5]. Technological advancements in this age continue to change teaching methods and to regulate the learning process. Changes that have taken place in this era show that the learning preferences of the current generation must be close to technology. Education must adapt to the changes brought about by the 4.0 Industrial Revolution. It is time for class

instructors to consider and integrate more technology into their teaching methods [6]. Education focuses more on the development of the quality of human life, both as individuals and as social beings, and is geared towards the development of technology itself.

The development of technology indirectly changes the perspective of education. The shift in education today is not just a concept of teaching, but it is far more essential, namely a change in perspective on the concept of education itself [7]. Education 4.0 is considered an opportunity for educational institutions that are ready to grow their students' readiness to enter a new round of the world of education that is changing so fast. Puncreobutr [8] revealed that students are required to be more creative and innovative in compensating for the changes that occur.

Teachers/lecturers as one of the main components in the world of education must be able to develop their competence in facing the 4.0 era. The teacher/lecturer must be rich in ideas to present interesting learning, can collaborate and communicate [9]. Also, teachers must not only be able to change the way of thinking of students facing all the barriers they experience but must be able to respond to the changing needs of students and adapt to the rapid development of technology. Teachers are also needed at this time to facilitate learning by providing technology-based learning resources. Thus, improving the quality of education must also be done to answer the challenges of this era.

The first thing that needs to be done in the modern phase of education is to train students to understand the idea well enough that it can be applied to daily life. Students must be able to interpret the theory and its application scientifically and be able to develop the science themselves [10]. Efforts must be made to master the concept of recording and transferring back the information from a subject matter [11]. Dimensions of cognitive outcomes to measure the mastery of these concepts are: remember, understand, apply, analyze, evaluate, and create [12]. Cognitive ability is important for students because it illustrates the mastery of students' concepts of the material being taught [13].

Students' understanding can also provide information on how students absorb, master, and store the material learned in the long term. Learning mechanics concept in higher education, students must master the concepts well. The concepts of mechanics are very difficult for students to understand [14]. The learning mechanics concept must use the right strategy so that the results are also more effective. One effective learning device that supports the development of the current era is a learning device based on technology.

One innovative learning device-oriented to information technology is the Learning Management System (LMS). LMS is a learning system that utilizes information technology in learning. LMS features that are designed as e-learning systems can be developed for social activities and assessments. Users such as students, lecturers, and administrators can manage schedules, work, discussions, lectures, and even research [15]. In higher education, the learning process applied by LMS can optimally manage learning thereby increasing effectiveness in the process [16]. In the process, LMS is used as an approach that can improve learning achievement [17] and efficiently used in learning [18] so that it can improve students' conceptual abilities [19]. The success of the LMS as a learning environment can encourage an increase in learning needs and student participation, to realize the expected goals [20].

Learning models that can support the use of LMS are blended learning models. Some exploratory studies about the use of blended learning provide valuable experiences for students. The use of complementary tools enables an effective learning process. Most students very well accept the use of blended learning. Many students note that accessing various sources through LMS on blended learning is very useful [21]. Blended learning is useful and effective in face-to-face and online learning. This study provides learning that is comprehensive and comparable to the needs of students [22]. Blended learning with LMS supports achievement. Cognitive abilities are found to have a positive relationship with an online performance that is applied in blended learning [23]. Based on the description above, this article discusses the results of LMS implementation in learning mechanics concept towards students' understanding. The use of LMS in learning is applied in the blended learning model.

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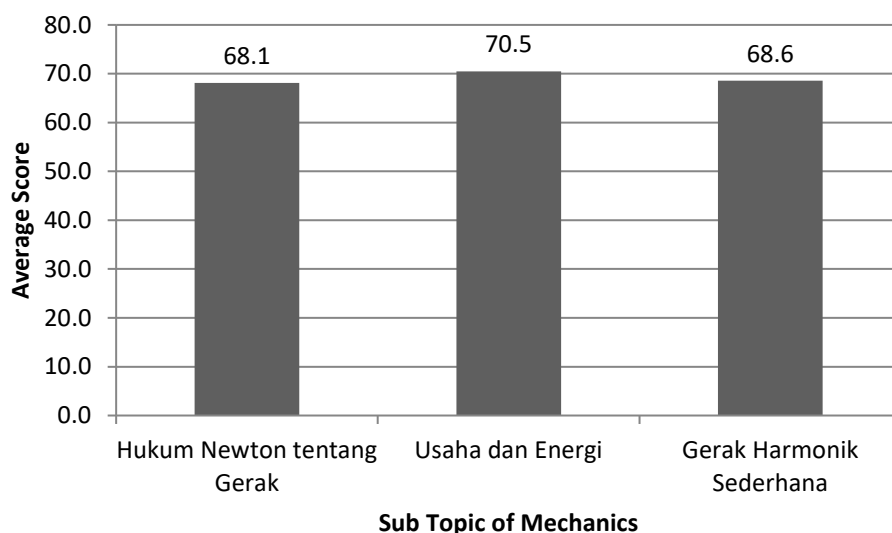


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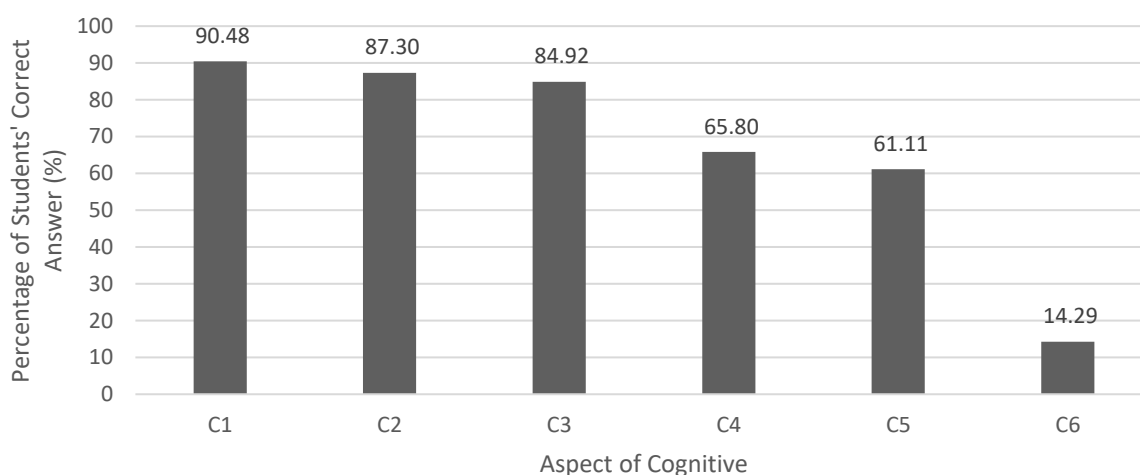


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