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Students' Cognitive Ability Improvement on Mechanical Wave Material with Chamilo Learning Media

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Abstract: The results of initial observations indicate that students' understanding of the concept of mechanical waves in the Basic Physics course still needs to be improved. The method used in this research is lesson study method with stages, namely plan, see, and do and also a single descriptive research with cognitive ability instrument to improve the quality of learning. The results of the normality test show a pre-test significance value of 0.07 and a post-test of 0.08, which indicates that the data is normally distributed. The paired t-test shows a significance value of 0.00 ($p < 0.05$), which means that there is a significant difference between the pre-test and post-test results. Meanwhile, the results obtained in this study are that there is an increase in students' cognitive ability with an N-gain result of 0.46 which is included in the moderate criteria (0.30 - 0.70). Therefore, it can be concluded that students' cognitive ability in learning mechanical waves increase after using Chamilo learning media.

Keywords: Chamilo; Cognitive ability; Mechanical wave

Introduction

Mechanical wave materials in the basic physics course that must be carried out by every university student, both from physics and physics education programs. In achieving the objectives of lectures on mechanical wave materials, students need cognitive ability. The five students' cognitive abilities that were assessed were from working memory, information processing, logical reasoning, representation, transformation of thinking, acquiring knowledge and effective research conclusions (Klahr & Wallace, 2022; Paz-Baruch & Maor, 2023; Peng & Kievit, 2020). Many students have not fulfilled the aspects of cognitive ability in mechanical wave lectures. This also happens to students in physics and physics education study programs at Jakarta State University.

Restructuring the educational process and modernizing the methodological system of education and the elements of the educational environment, in particular, the forms, methods and means of teaching based on the widespread use of information and communication technologies are the main goals for developing students' competencies. This creates favorable conditions for intensifying the cognitive activity of students who can increase their active role in the lecture process (Denisova et al., 2021). The dimension of knowledge in the development of cognitive ability consists of four types of knowledge, including factual, conceptual, procedural, and metacognition (Rozi et al., 2024). However, in this study the cognitive abilities assessed prioritize conceptual and factual aspects.

Students cannot processing the information and logical reasoning in lectures due to a lack of cognitive ability (Wardhana & Rofi, 2022). This is shown when before starting the mechanical wave lecture, a pre-test is conducted in an effort to find out students' initial understanding of the material. One strategy in lectures to improve students' cognitive ability in studying basic physics is using effective and interesting learning media (Silfiani et al., 2022). The criteria for effective learning

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media are that it is appropriate to the learning outcomes of the course, easy to use and obtained by lecturers and students, includes the learning model applied to the course (Hardiansyah & Mulyadi, 2022). Choosing the right learning media is also expected to help the process of improving student abilities, one of which is cognitive ability. Students will better understand difficult physics material if they are assisted with learning media that is appropriate to the lecture objectives (Al-Qoyyim et al., 2022; Banda & Nzabahimana, 2023; Schneider et al., 2022).

However, it is not enough just the media, the learning model applied in the lecture must be appropriate (Simanjuntak et al., 2021). With collaboration between appropriate media and learning models, mechanical wave material in basic physics lectures will become easier (Rahim et al., 2022). The learning model applied in the basic physics course on mechanical waves is based on problems and cases. All learning materials and models are integrated in a learning media called Chamilo. Chamilo is one of the open source learning media that emphasizes the source that focuses on building an e-learning portal with easy and fast (Yulita et al., 2018). The reason for choosing Chamilo as a physics learning media is that it has various interesting and interactive features and is complete enough to carry out online lectures (Azairok & Fathurohman, 2023). By developing learning media like this, lectures will be more effective because they are easy to carry out and can be accessed anytime and anywhere according to students' needs (Bunari et al., 2024; Tuma, 2021).

Chamilo can be developed according to user needs and of course covers all course outcomes. The features contained in Chamilo are specifically for lectures so that students can carry out lectures even though they are not in the classroom. These features include documents that can contain teaching materials in the form of modules, quizzes for pre-tests and post-tests, assignments for collecting assignments given, hyperlinks for embedding learning videos, and communication features between lecturers and students who are part of the course. All of these features can be developed by creators according to course achievements, the learning model applied, and the material presented, namely mechanical waves.

The use of Chamilo as a learning management system is very rare. Most teachers use websites such as Weebly, Google Sites or other learning management system in the form of Moodle. This happens because Chamilo requires money to develop it to make it more accessible to users. By increasing students' understanding of the material, their cognitive ability will improve and they will also be able to think critically and logically (Skulmowski & Xu, 2022).

So, this research focuses on improving students' cognitive ability in studying mechanical wave materials in basic physics courses using Chamilo learning media.

Method

This research is classroom action research using the lesson study method. Lesson study can be defined as a model for professional development of educators through collaborative and sustainable learning evaluation (Keliat et al., 2025). This model is based on the principles of cooperation and shared learning, with the aim of building a learning community. This method has several steps, as in Japan according to Lewis and O'Connell who expressed their opinion in 2006, namely collaborative planning, observation and analysis of actual learning (Kim et al., 2021). Meanwhile, in this research, the learning steps applied in lesson study, namely Plan, Do, and See, are based on the theory put forward by Herawati Susilo regarding lesson study (Andromeda et al., 2023; Indriwati et al., 2018). The lesson study activities carried out in this research is illustrated in Figure 1.

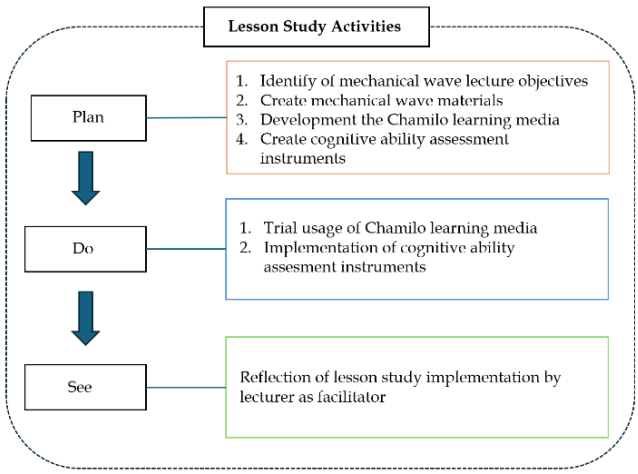


Figure 1. Lesson study activities

This research was conducted at Jakarta State University with the subjects consisting of the Physics Education study program with 40 students and Physics with 39 students. The subject is divided into two classes as a minimum cycle in implementing lesson study (Kandaga et al., 2021). This research using two classes and also uses calculations based on N-gain to determine the increase in students' cognitive ability (Lasaiba, 2023; Safitri et al., 2023).

N-gain can be calculated with the following formula:

$$N\ gain = \frac{Postest\ Score - Pretest\ Score}{Maximum\ Score - Pretest\ Score} \quad (1)$$

The n-gain score consists of three categories, namely high (n-gain > 0.70), moderate (0.30 < n-gain < 0.70), and low (n-gain < 0.30) (Doyan et al., 2022; Susilawati et al., 2022).

In addition, the pre-test and post-test data were tested for normality and homogeneity as one of the statistical tests using IBM SPSS software.

Result and Discussion

Plan

In the plan stage, the main thing to do is identifying the objectives lecture of mechanical wave materials. The objectives of this lecture on mechanical waves include explaining the phenomena, types, and properties of waves, explaining the relationship between wave quantities and the traveling wave equation, calculating the speed of rope waves in the Melde Experiment and explaining the concept of superposition and describing the stationary wave equation. The next stage is to create materials in accordance with the lecture objectives. All mechanical wave materials that have been compiled are then applied to the Chamilo learning media. The developed Chamilo as shown in Figure 2.

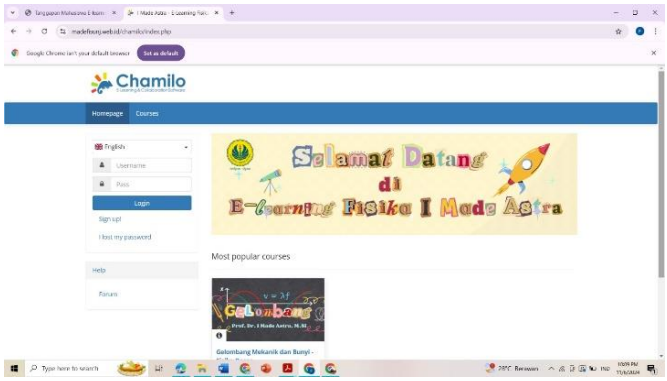
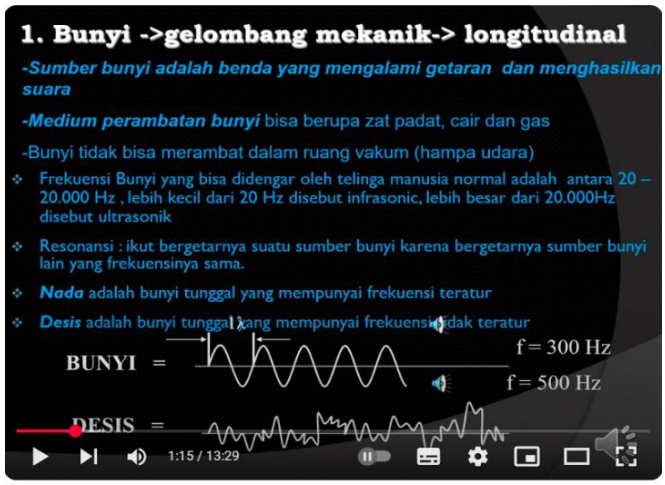


Figure 2. Chamilo display

After developing Chamilo, an assessment instrument for students' cognitive abilities was developed. The aspects assessed include working memory, information processing, logical reasoning, representation, transformation of thinking, and acquiring knowledge (Klahr & Wallace, 2022).

Do

At this stage, we tested the use of Chamilo. This trial was conducted for 3 semester credit units x 50 minutes. The first trial was conducted on Physics Education class and the second trial was conducted on Physics class. Before studying mechanical wave material, students are required to take a pre-test to determine students' initial understanding of the material to be studied. It is also part of the cognitive ability assessment instrument. Students are required to access the mechanical wave video that has been included in Chamilo as shown in Figure 3.



Gelombang Mekanik P1 #merdekabelajar #fisika

Figure 3. Video of mechanical wave material

After students pay attention to the video, they are required to access the module which contains material along with exercise questions and post-test questions. The post-test was done individually to determine the improvement of students' understanding of mechanical waves after using Chamilo as a learning media. The post-test is also a form of cognitive ability assessment instrument developed in this study.

See

This stage is a lecture reflection stage that evaluates students' cognitive abilities before and after using Chamilo. In this stage, the average pre-test and post-test scores were calculated. The assessment is divided into two classes, namely Physics Education (PE) and Physics (P). The calculation can be seen as in Table 1.

Table 1. Pre-test Average Scores

Cognitive Ability Indicators	Class	
	PE	P
working memory	63.21	62.35
information processing	60.54	65.12
logical reasoning	58.73	60.41
representation	61.18	63.38
transformation of thinking	60.47	59.72
acquiring knowledge	59.80	59.06

Table 1 is the average value of the pre-test conducted in both classes. It can be seen that every indicator of cognitive ability assessed, students get unfavorable results. After being given material through videos and modules included in Chamilo, the cognitive ability scores obtained by students are written in Table 2.

Table 2. Post-test Average Scores

Cognitive Ability Indicators	Class	
	PE	P
working memory	83.75	82.55
information processing	80.45	83.24
logical reasoning	85.36	84.80
representation	82.18	83.67
transformation of thinking	84.28	85.07
acquiring knowledge	85.08	84.71

The results obtained during the post-test showed that there was an increase in each indicator of students' cognitive ability. To find out further improvements in cognitive ability based on the data in Table 1 and Table 2, this research using the normality test to determine whether the data is normally distributed or not, t-paired test to determine the significance of the data and also the N-gain test to determine the criteria for improving students' cognitive ability. T-paired test is particularly useful for evaluating the impact of interventions or changes in teaching methods and learning media on student performance (Hu-Au & Okita, 2021; Sharma & Alvi, 2021). Meanwhile, the N-gain test was used with the aim of statistically calculating the increase in concept understanding ability after being given a teaching method with the assistance of learning media (Tsivitanidou et al., 2021).

Normality, Paired Sample T-test and N-gain Results

The first statistical test carried out in this study was the normality test. This test uses the assistance of IBM SPSS Statistics 25 and uses the Shapiro-Wilk model. The results obtained in this test are shown in Table 3.

Table 3. Normality Test Results

Learning Activity	Mean	Sig.	Category
Pre-Test	71.75	0.07	Normal
Post-Test	84.65	0.08	Normal

In the normality test, the data can be said to be normally distributed if the sig value. > 0.05, while if the sig value. < 0.05 (González-Estrada et al., 2022; Khatun, 2021). Based on Table 3, the significance value obtained in the pre-test activity is 0.07 while in the post-test activity it is 0.08. So, the results of the normality test, it is found that the data is normally distributed.

After conducting a normality test, this study also conducted a paired sample t test. The test result data is shown in Table 4.

Table 4. Paired Sample T-test Results

Learning activity	Std. deviation	Std. Error Mean	Sig. (2-tailed)
Pre-Test & Post-Test	5.38	1.26	0.00

In testing paired sample t-tests, data can be said to have a significant difference if the sig value. (2-tailed) < 0.05. Meanwhile, the data is said to have no significant difference if the sig value. (2-tailed) > 0.05 (Fatmawati & Andriani, 2024; Pigai & Yulianto, 2024). In this study, the paired sample t-test results are listed in Table 4 with sig. (2-Tailed) = 0.00 < 0.05. So, based on these results it can be said that there is a significant difference in the cognitive abilities of students both before and after using Chamilo learning media.

The test that was also carried out in this study was to determine the N-gain value. Table 5 shows the calculation results of the N-gain value based on the pre and posttests that have been carried out.

Table 5. N-gain Results

Mean pre-test score	Mean post-test score	N-gain	Criteria
71.75	84.65	0.46	Medium

Based on the N-gain results shown in Table 5, it was found that the value was 0.46 and included in the medium category. It can also be said that there is an increase in students' cognitive abilities in learning mechanical wave material through Chamilo learning media.

Research on Chamilo is still limited and tends to focus on usage and user experience with the platform. This is an interesting topic that needs to be studied. Chamilo has a more attractive appearance than Moodle because the menus are icon-based. In terms of features, it is similar to the features provided by Moodle (Nasrum et al., 2023). Currently, one of the most studied and reliable indicators of academic success is cognitive ability (Stadler et al., 2016). Students' capacity to succeed academically is significantly hampered by their cognitive ability, which includes attention, memory, and reasoning skills, is the term used to describe the human brain's capacity to process, retain, and retrieve information. It is a crucial psychological component for people to finish an activity successfully (Shi & Qu, 2021).

In this research, Chamilo which is used as a learning media in assisting to improve students' cognitive ability in mechanical wave material is quite successfully implemented. Students' cognitive ability increase along with the fulfillment of knowledge in the five aspects mentioned in the introduction of this study. With the assistance of Chamilo learning media, students can process information, explain, represent mechanical wave material. This is reinforced based on the Paired Sample T test and the N gain test which shows an increase in cognitive abilities in students. Chamilo as a learning media has great potential to be developed. With its various features, learning will be more effective. This will also make students' learning motivation increase so

that their cognitive abilities will be better (Putra et al., 2019).

Conclusion

Based on the results of Paired Sample T-tests in the Sig. (2-tailed) found that the value is 0.000 which means that there is a significant difference in the cognitive abilities of university students in using Chamilo learning media for mechanical wave material, while the N-gain result of 0.46 shows that there is an increase in students' cognitive abilities which are categorized as medium. Therefore, it can be concluded that the cognitive abilities of university students increased with the assistance of Chamilo learning media.

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Conceptualization: IMA and IGIA; Instrument development: HK; Instrument validation: IMA; Data collection: IMA and HK; data analysis and interpretation: IMA and IGIA; initial draft-writing: HK; writing-review & editing: IMA and HK. All authors have reviewed the results and approved the final version of the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest.

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