

Conceptual Understanding and Problem-Solving Skills: The Impact of Hybrid Learning on Mechanics

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ABSTRACT

Mechanics is a challenging topic not only for the students majoring in physics but also for those who are not majoring in physics. This study aims to discover the correlation between students' conceptual understanding and problem-solving skills experienced by students who major in natural science. The analysis was conducted after the course had been delivered using the hybrid-learning method. Students' conceptual understanding was measured using 13 multiple-choice questions while their problem-solving skill was measured using 3 essay questions. The normality, the linearity, and the correlation of the data were analyzed. The data is normally distributed with the average score of students' conceptual understanding was 83 and the average score of students' problem-solving skills was 48. The linearity test shows that there is a significant linear correlation between students' conceptual understanding and problem-solving skills. However, the Pearson Correlation test result shows that there is no significant positive correlation between the two variables with the coefficient of determination was only 15.4%.

Keywords: Conceptual understanding, problem-solving skill, correlation, hybrid-learning

INTRODUCTION

The advancement of technology has brought various fields into the next level not only in pure science sector but also in the educational sector (Affriyenni & Swalaganata, 2020; Bressler & Bodzin, 2013; Dancy & Beichner, 2006; Kurniawan et al., 2020; Swalaganata et al., 2018). One of the uses of technology in the educational field is the use of the internet in the learning process. Commonly, the use of the internet is combined with the conventional learning method thus called hybrid learning. Hybrid learning has been

utilized in enhancing either students' conceptual understanding or students' problem-solving skills (Affriyenni et al., 2014, 2020).

Several works had been done in the effort of enhancing students' conceptual understanding of physics. These works might have involved a specific learning strategy or the utilization of learning tools (Huffman, 1997; Hung & Jonassen, 2006). Significant enhancement was experienced by the learning process assisted by the use of computer-based technology either

through simulations, virtual manipulation or by the use of animations (Z. Zacharia & Anderson, 2003; Z. C. Zacharia & Constantinou, 2008).

The use of technology had been conducted previously to change students' perspectives in understanding kinematics and thermodynamics. A computer-based assessment had been developed and shows that there was a significant improvement in students' conceptual understanding by using this strategy (Dancy & Beichner, 2006). The web-based assessment had been developed to enhance either the conceptual understanding and problem-solving skills in thermodynamics (Affriyenni et al., 2014).

Unfortunately, conceptual understanding is not the only competence needed to overcome real-life problems. Students are needed to be able to overcome the crisis by using their skills in solving problems. Hence, problem-solving skill is one of the necessary skills in the 21st century (OECD, 2017). Problem-solving measures students' ability to apply physics knowledge to accomplish an objective. Assessing students' components of skills involved in problem-solving could help in improving the strategy of the learning process. However, the assessment of students' problem-solving skills is not related directly to their cognitive structure (Gerace, 2016). Thus, we need appropriate instruments to measure students' conceptual understanding and their problem-solving skills separately. Hence, this work decided to use the multiple-

METHOD

As previously explained, this study aims to find the correlation between students' conceptual understanding and problem-

choice type of question to measure students' conceptual understanding and the essays to measure students' problem-solving skills.

The advantages of using multiple-choice questions to measure students' conceptual understanding are related to its characteristics of being able to represent its content, more objective, could avoid subjectivity, and it is easier and faster to be assessed. Meanwhile, the advantages of using essays type questions are easier to prepare, minimizing the probability of speculations among students, encouraging students to be brave in stating their opinions, providing opportunities for students to explain the materials using their language style, and providing students' knowledge depth based on the provided problems (Arikunto, 2010).

Mechanics is one large topic delivered in the course mechanic and electromagnetics course. Based on the curriculum developed, it needs half of the semester to cover the rigid body, static fluid, and dynamic fluid subtopic. Mechanics is still a challenging topic for students especially those who are not majoring in physics. This study aims to discover the correlation of students' conceptual understanding and problem-solving skills of students majoring in natural science, hence they are not specifically majoring in physics. The course itself was delivered using a hybrid method that combines conventional lecture and online learning using the LMS Moodle platform.

solving skills after taking mechanics and electromagnetics course delivered using the hybrid-learning method. This study

took place in the first half of the odd semester in the academic year of 2019/2020 including the preparation, the implementation, and the data analysis. The course was provided for the students of natural science education study program in Universitas Negeri Malang and delivered using the hybrid-learning method.

The population of this study was the 3rd-semester students in the natural sciences study program. The sample was 31 students taken using *cluster random sampling* with the population assumption to be homogenous. The assumption was made based on the relatively similar characteristics of having the same learning material based on the same curriculum, the same time allocation for learning, the whole classes were taught by the same lecturers, and the class configuration was only based on English capability, not by their intelligence.

Data acquisition was conducted using the documentation method and the test method. The documentation was conducted to obtain students' identity before being the sample of this study. The test used two kinds of instruments including the multiple choices and the essays. The multiple-choice questions were used to test students' conceptual understanding of mechanics. Meanwhile, the essays were used as the instrument to measure students problem-solving skill.

The tested materials focused on mechanics provided in the first half of the semester including a rigid object in equilibrium and fluids topics. The test instruments consisted of 20 numbers including 13 multiple-choices and 3 essays covering the subtopics of a rigid object in equilibrium, static fluids, and dynamic fluids. The time allocation for the test was

100 minutes which was equivalent to 2 study hours.

The data analysis includes the normality test, the linearity test, and finding the correlation coefficient. The normality test was conducted to find out about the distribution characteristics whether they were normally distributed or not (Sudjana, 2002). The test used the Kolmogorov-Smirnov normality test.

The linearity test was conducted to find out about the linearity of research data distribution. Moreover, it aims to find out if two variables are linearly correlated to each other (Sugiyono, 2017; Winarsunu, 2002). In this case, the linearity test was aimed to find out whether the conceptual understanding was linearly correlated to students' problem-solving skills or not.

Finding the correlation coefficient is one way to test the hypothesis. The coefficient of correlation a statistic tool to compare the measuring results of two different variables to determine the level of correlation between these variables. This study tried to find the correlation between students' conceptual understanding of mechanics and their ability in solving the provided problems. This study used the product-moment Karl-Pearson formula to test the correlation between two variables using ratio-scale data. The formula is provided below (Arikunto, 2010).

$$r_{xy} = \frac{N \sum XY - \sum X \sum Y}{\sqrt{N \sum X^2 - (\sum X)^2} \cdot \sqrt{N \sum Y^2 - (\sum Y)^2}} \quad (1)$$

The hypothesis for this study was:

$H_0: \mu = 0$, there is no positive correlation between X and Y

$H_1: \mu \neq 0$, there is a positive correlation between X and Y

Where X symbolizes the conceptual understanding and Y symbolizes the problem-solving skill.

Moreover, a determination coefficient was used to determine the magnitude of the correlation between a dependent and an independent variable. In this study, the dependent variable was the

problem-solving skill while the independent variable was the conceptual understanding. The determination coefficient of students' conceptual understanding of the problem-solving skills was calculated using Eq. (2).

$$\% = r_{xy} \times 100\% \quad (2)$$

RESULTS AND DISCUSSION

The data of conceptual understanding and problem-solving scores were obtained through a test. These data have been

analyzed to answer the hypothesis. The scores are shown in Table 1.

Table 1. The scores of students' conceptual understanding and problem-solving skills through multiple-choice and essay tests

Students' Code	Score	
	Multiple Choice	Essay
A-1	85	33
A-2	100	33
A-3	85	54
A-4	77	33
A-5	92	54
A-6	77	63
A-7	77	38
A-8	77	46
A-9	77	42
A-10	92	50
A-11	85	52
A-12	92	54
A-13	92	100
A-14	85	38
A-15	100	50
A-16	85	50
A-17	62	42
A-18	85	42
A-19	69	96
A-20	69	33
A-21	85	42
A-22	85	42
A-23	69	46
A-24	85	50
A-25	85	46
A-26	77	46

A-27	100	58
A-28	77	46
A-29	69	33
A-30	77	33
A-31	92	58
A-32	85	33

The distribution of students' conceptual understanding is shown in Table 2 which is summarized using the following calculations based on the data in Table 1.

Maximum Score = 100

Minimum Score = 62

Range (R) = $100 - 62 = 38$

$$\begin{aligned} \text{Number of Classes } (C) &= 1 + 3.3 \log(31) \\ &= 5,97 \\ &\approx 6 \text{ classes} \end{aligned}$$

$$\begin{aligned} \text{Class Length } (L) &= \frac{38}{6} \\ &= 6,45 \\ &\approx 6 \end{aligned}$$

Table 2. Distribution of Students' Conceptual Understanding

No	Scores	Frequency
1	62-67	1
2	68-73	3
3	74-79	8
4	80-85	10
5	86-92	5
6	93-100	4
Total		31

Meanwhile, the distribution for problem-solving skills is shown in the following Table 3. The following calculations are also done based on the data in Table 1.

Maximum Score = 100

Minimum Score = 33

$$\text{Range } (R) = 100 - 62 = 67$$

$$\begin{aligned} \text{Number of Classes } (C) &= 1 + 3.3 \log(31) \\ &= 5,97 \\ &\approx 6 \text{ classes} \end{aligned}$$

$$\begin{aligned} \text{Class Length } (L) &= \frac{67}{6} \\ &= 11.17 \\ &\approx 11 \end{aligned}$$

Table 3. Distribution of Students' Problem-Solving Skills

No	Scores	Frequency
1	62-67	13
2	68-73	13
3	74-79	3
4	80-85	0
5	86-92	0
6	93-100	2
Total		31

The average score of students' conceptual understanding is 83 with the mode is 85 and the median is 85. Meanwhile, for students' problem-solving skills, the average is 48 while the mode is 33 and the median is 46. The distribution of students'

conceptual understanding score is shown more clearly in the following Figure 1 while the comparison of students' problem-solving scores is shown in Figure 2.

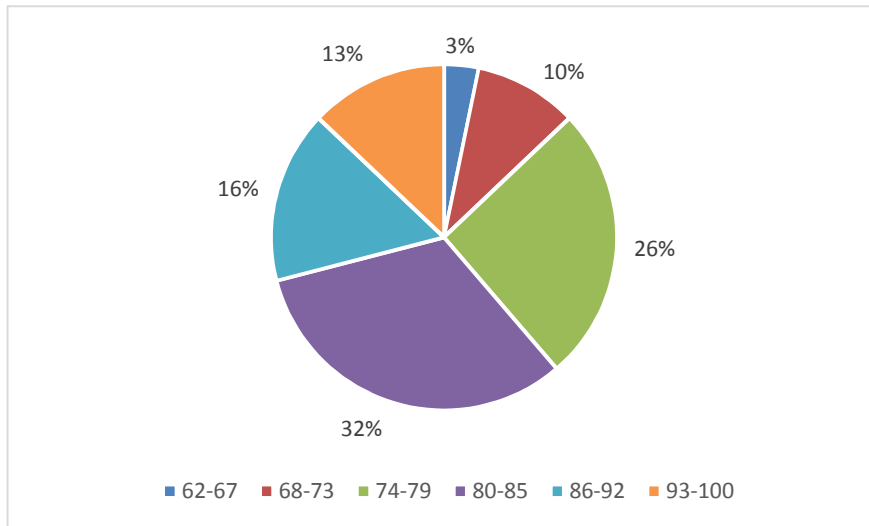


Figure 1. The Distribution of Students' Conceptual Understanding

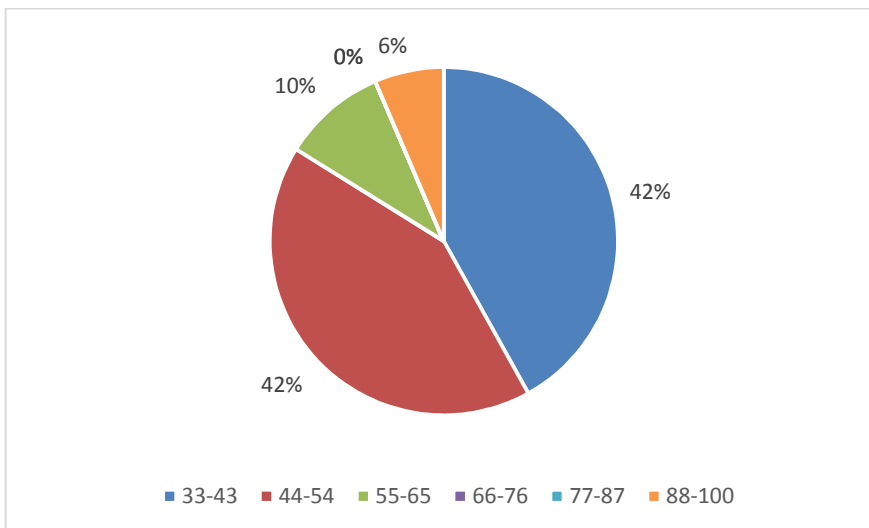


Figure 2. The Distribution of Students' Problem-Solving Skill

The results of the normality test are shown in Table 4. Since the significance value $Sig. = .059 > .05$, we can conclude that the data is normally distributed. Furthermore, the linearity of the data had been tested and shown in Table 5. Since the Deviation from Linearity $sig. .0247 > .05$, we can conclude that there is a significant linear

correlation between students' conceptual understanding and their problem-solving skills. Meanwhile the $F_{counted} = 1.450 < F_{table} = 4.35$ which means that there is a significant linear correlation between the variable of students' conceptual understanding and problem-solving skill.

Table 4. One-Sample Kolmogorov-Smirnov Test

		Unstandardized Residual
Most Extreme Differences	Positive	.238
	Negative	-.117
Kolmogorov-Smirnov Z		1.327
Asymp. Sig. (2-tailed)		.059

Table 5. Linearity Test of Students' Problem-Solving Skill Towards Their Conceptual Understanding

			F	Sig.
Problem-Solving* Conceptual Understanding	Between Groups	(Combined)	1.309	.292
		Linearity	.747	.396
		Deviation from Linearity	1.450	.247
Within Groups				
Total				

For the correlation test, the analysis result is shown in Table 6. Since the Sig. value is $.408 > .05$ hence there is no correlation between students' conceptual understanding and their problem-solving skills. Furthermore, the counted Pearson Correlation is $.154$ which is smaller than the table value of $.355$ for data degree of freedom 29. Hence the proposed hypothesis H_0 is accepted which means that there is no significant positive

correlation between students' conceptual understanding and their problem-solving skills.

Moreover, based on the Pearson Correlation calculation, we can calculate the determination coefficient as much as $\% = .154 \times 100\% = 15.4\%$ which means that students' problem-solving skill was only correlated as much as 15.4% to their conceptual understanding in mechanics.

Table 6. Pearson Correlation Analysis

		Conceptual Understanding	Problem-Solving
Conceptual Understanding	Pearson Correlation	1	.154
	Sig. (2-tailed)		.408
	N	31	31
Problem-Solving	Pearson Correlation	.408	1
	Sig. (2-tailed)	31	
	N		31

CONCLUSION

The data is normally distributed with the average score of students' conceptual understanding was 83 and the average score of students' problem-solving skills

was 48. The linearity test shows that there is a significant linear correlation between students' conceptual understanding and problem-solving skills. However, the

Pearson Correlation test result shows that there is no significant positive correlation between the two variables with the

coefficient of determination was only 15.4%.

ACKNOWLEDGEMENT

The authors acknowledge the contribution of our colleagues in the Natural Sciences Education Study Program, Faculty of Mathematics and Sciences, Universitas Negeri Malang for their wonderful insights and meaningful discussion in the working of this study.

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