

The Influence of Multiple Representation-Based Online Lectures Using Geogebra on Understanding of Students' Thermodynamics Concepts During the Covid-19 Pandemic Period

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ABSTRACT

This study aimed to determine the effect of online lectures Via Zoom in thermodynamics courses based on multiple representations using Geogebra on students' conceptual understanding in the midst of physical standing conditions (Pandemic Covid-19). The research method used is pre-experimental design (nondesigns). The research phase includes preliminary studies, including field surveys and literature studies. The stage of designing and reviewing test instruments based on Multiple Representations (MR). The MR-based test instrument was then used as an instrument to perform the pretest and posttest. From the analysis of research data, it was found that the average value of students' conceptual understanding before being given treatment was 42, while the average value of student learning outcomes after being given treatment was 77. After the calculations were carried out for hypothesis testing, it was obtained that t count was 4.293 and t table was 1.318, because t arithmetic > t table that is $4.293 > 1.318$ then H_0 is rejected. Thus H_1 is accepted which states that there is an effect of online lectures via zoom in the thermodynamics subject based on multiple representations using Geogebra on students' conceptual abilities in the midst of the covid -19 pandemic.

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1. INTRODUCTION

Physics is a branch of Natural Sciences (IPA) which is essentially a collection of knowledge (a body of knowledge), investigation (a way of investigating), and a way of thinking (a way of thinking). In the sense of being a body of knowledge, physics is the result of findings based on various research activities by scientists (Busyairi et al., 2021). The collection of knowledge can be in the form of concepts, laws, principles, models or theories.

Concepts are verbal symbols that are used to explain complex realities. With concepts, one can simplify his thinking for several events that are related to one another (Ismet, 2019). The learning process in schools is one of the tools of public policy in an effort to increase understanding and skills. More than that, many students think that school is a very fun activity, students can interact directly with each other. However, due to the disruption of the COVID-19 pandemic, teaching and learning activities at schools were suspended (Naram & Poluakan, 2021). However, the educational process must continue. Schools must force themselves to carry out online learning. There are also schools that carry out learning in schools but not as usual where activities at school are limited.

The Thermodynamics course was one of the courses that was running when the COVID-19 pandemic hit. With that situation, many students have difficulty especially understanding the basic concepts of thermodynamics. Based on the results of interviews, 70% of students have difficulty in understanding the concept of thermodynamics. This is because learning has not implemented effective and efficient learning media so that learning is still monotonous and makes students bored, especially when it is exacerbated by the COVID-19 pandemic which requires face-to-face learning to become virtual face-to-face learning.

In an effort to maximize the understanding of these students, as a lecturer, there are many things that have been prepared in lectures, one of which is geogebra media. GeoGebra is a dynamic math application for learning math and science. The GeoGebra application was developed by Markus Hohenwarter and his team of programmers. With this program, students can be fully involved in building their own animations of moving objects so that conceptual understanding, analytical and numerical skills can be improved (Rabiulluddin, 2018). Geogebra media is a form of learning implementation that utilizes technology and is not limited by space and time. The existence of ICT can provide a new nuance to encourage a better learning process.

In addition, studying thermodynamics conceptually can lead students to understand physics concepts in various representations. Students practice translating one concept in various different representations, and are trained to be able to pour a physics concept into various forms of representation. This opinion is in line with the statement of Namdar and Shen who explain that the use of multi-representation learning can create a more comprehensive knowledge base that can improve student learning outcomes (Namdar & Shen, 2013). So the use of multi-representation learning is very important because in the discussion of thermodynamics there are many multiple representation skills such as pictures, simulations, mathematical equations that must be explained to students. In this context, a lecturer needs to present it in various representation formats.

Empirical research related to the application of multiple representations in improving students' understanding of concepts has been done before. The results of research by (Hasbullah, Halim, & Yusrizal, 2019) and (Kurniasih, Novia, & Jauhari, 2020) show that the use of various representations in physics learning can improve students' conceptual understanding. This study aims to see how the effect of multi-representational learning in improving conceptual understanding students at the University level.

Therefore, based on these problems, researchers use zoom in carrying out lectures. It is suspected that online lectures in thermodynamics courses based on multiple representations using Geogebra will have a positive influence on students' understanding of concepts in the midst of physical standing conditions (Pendemic Covid-19).

2. METHODS

In this study, the research method used was pre-experimental designs (non designs) . It is called by pre-experimental design, because this method is not yet a real experiment. In addition, it is called so because in this type of experimental design there are also external variables that also influence the formation of the dependent variable. So the experimental results which are dependent are not solely influenced by the independent variables.

In this study, the researcher used a one group pretest-posttest research design. In this study, only one experimental group was given treatment in the learning process, namely Online Lectures Via Zoom

in Thermodynamics Subjects Based on Multiple Representations Using Geogebra. The test was carried out 2 times, namely before the experiment and after the experiment. The instrument used is an assessment based on Multiple Representations

3. FINDINGS AND DISCUSSION

Validation Test Results of Multiple Representation Based Test Instruments

The questions developed in this study were 8 questions about concepts understanding based on multiple representations. The validity test of the test instrument based on multiple representations was carried out by empirical testing using the method of distributing questionnaires to experts. In this case, the researcher validated 3 aspects by 2 experts, namely construction, substance and language. The results of the validation test can be seen in the table below.

Table 1 Results of MR-Based Test Instrument Validation by Experts

No	Assessment Aspect	Overall Percentage (%)	Interpretation
1	Construction	87,5	Excellent
2	Substance	83,33	Excellent
3	Language	87,5	Excellent
Average percentage		86,11	Excellent

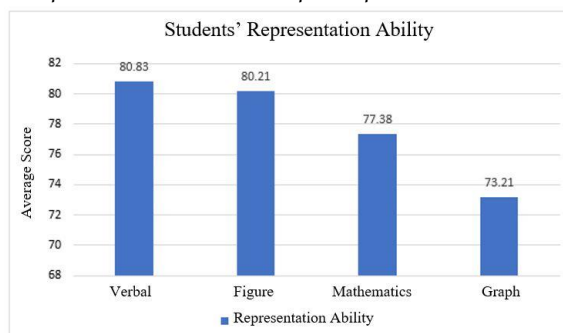
Based on the table of validation results above, the construction aspect is 87.5% with a very good interpretation, the substance aspect is 83.33% with a very good interpretation, the language aspect is 87.5% with a very good interpretation while the average percentage of the overall assessment of aspects is 86.11%.

These results indicate that the multiple-representation-based question instrument viewed from the aspect of substance, construction, and language has a very good interpretation. From these results, it can be stated that the learning assessment tool developed is suitable for use in thermodynamics lectures.

Student's Multiple Representation Ability

In the thermodynamics lecture process, this research has succeeded in involving students even though the lectures are only online. All students have the opportunity to get an explanation of the concepts of thermodynamics through the presentation of various representation formats such as verbal and visual representations e.g., verbal abilities, pictures, graphs, tables, or diagrams with the help of geogebra applications. The results of the Multiple Representation abilities obtained by students are shown in the following graph:

Graph 4.1 Students' Multiple Representation Ability



Results of Students' Conceptual Understanding

Based on the results of the research, the data obtained from students' conceptual understanding after being given MR-based learning online using Geogebra media. Students' conceptual understanding is obtained by using the results of the pretest and posttest. Data on students' concept understanding can be seen in the following table:

Table 2 Conceptual Understanding of the students

NO	STUDENTS' NAME	MR Score				Pretest	Posttest
		Verbal	Graph	Figure	Math		
1	RAFIRIZQI SALIM	75	70	72	55	25	65
2	JIHAN MUNA WAROH	80	80	80	70	46	76
3	SYIFA ARIAMA	80	85	78	70	45	77
4	ANAZ NAZMULLAELA	85	80	75	75	37	77
5	ANDRENY DWI NURLITA	75	75	76	70	33	73
6	DESTI SETIANINGRUM	85	85	80	80	41	82
7	FAKHIRA NURSABRINA	80	80	80	70	36	76
8	ASLIHATUN NIKMAH	80	80	82	70	47	77
9	NURAENI NANDA SARI	85	85	76	85	45	83
10	MUTIARA RAMADHANI	85	80	75	80	50	79
11	NABILA SEKARINI RAMADHAN	85	85	76	80	55	81
12	NUR MUHAMMAD FARHAN	80	85	80	85	40	83
13	DIKTA NURUL MAHFY YAH	80	80	80	75	48	78
14	LINA DINDA AULIA	85	80	76	77	45	78
15	HAFLAN NUR IMAN	75	75	75	60	44	69
16	ADILA NAILUFAR	80	80	78	70	35	76
17	PRASETYO RIDO WICAKSONO	75	70	75	65	30	70
18	NURULITA PURNAMA PUTRI	80	80	80	80	35	80
19	MUHAMAD FACHRY SEPTIAN	80	85	78	70	46	77
20	MAURINA NUR FAIDAH	80	85	78	80	40	81
21	NASSA KHARISMA	85	80	80	75	48	79
22	INTAN DIAN STEPEN	85	80	75	75	47	77
23	GHINA EL HIDAYAH	75	80	75	70	44	74
24	RAHMAH IZZATI ALHAQ	85	80	77	70	45	76
		81	80	77	73	42	77

Testing Requirements Analysis

In this study, the analysis requirements test used was the normality test and the homogeneity test.

a. Normality test

The normality test used for the experimental class was the Lilliefors test for the estimated error at a significant level = 0.05 with the following hypothesis:

H₀ : Data is normally distributed

H₁ : Data is not normally distributed

Accept H₀ If L_{count} < L_{table}, the data is normally distributed

Accept H₁ If L_{count} > L_{table}, the data is not normally distributed

Table 3 Normality Test Results

Class	N	L _{count}	L _{table}	Conclusion
Experiment	24	0,094	0,200	Normal

Based on the table above and the test criteria above, the calculated L_{price} is 0.094. while the price of L_{table} at = 0.05 with dk = 24 that is equal to 0.200. Thus, L_{count} < L_{table} is 0.094 < 0.200, this result indicates that the estimated Y error score over X comes from a normally distributed population.

b. Homogeneity Test

The homogeneity test used in this study was the Bartlett test at a significant level = 0.05 with the following hypothesis:

H_0 : Variance of homogeneous data

H_1 : Data variance is not homogeneous

Reject H_0 if $\chi^2_{count} > \chi^2_{table}$, the data variance is not homogeneous.

Accept H_0 if $\chi^2_{count} < \chi^2_{table}$, the data variance is homogeneous.

Table 4 Homogeneity Test Results

Class	N	χ^2_{count}	χ^2_{table}	Conclusion
Experiment	24	9,239	12,592	Homogeneous

Based on the table and the test criteria above, the value of χ^2_{count} is 9.239 , while the price of χ^2_{table} is at $\alpha = 0.05$ with $dk = 6$ which is 12.592 . Thus $\chi^2_{count} < \chi^2_{table}$ that is $9,239 < 12,592$ so accept H_0 . The results of this test can be concluded that the grouping of posttest data on pretest has a homogeneous variance.

Hypothesis testing

Then in order to see the effect formed by X (pretest) on Y (posttest), it is necessary to test the hypothesis. In testing the hypothesis, the t-test formula is used at the significant level $\alpha = 0.05$ and $\alpha = 0.01$ and degrees of freedom (dk) 24 with the following hypothesis:

H_0 : There is no influence of online lectures via zoom in the thermodynamics subject based on multiple representations using Geogebra on students' conceptual skills in the midst of the covid-19 pandemic.

H_1 : There is an influence of online lectures via zoom in the Thermodynamics subject based on multiple representations using Geogebra on students' conceptual skills in the midst of the covid-19 pandemic.

Reject H_0 if $t_{count} > t_{table}$, there is an influence of online lectures via zoom in a thermodynamics course based on multiple representations using Geogebra on students' conceptual abilities in the midst of the covid-19 pandemic.

Accept H_0 if $t_{count} < t_{table}$, there is no influence of online lectures via zoom in the thermodynamics subject based on multiple representations using Geogebra on students' conceptual abilities in the midst of the covid-19 pandemic.

Table 5 . Hypothesis Testing Results (t-test)

Variable	t_{count}	t_{table} $\alpha = 0,05$	Conclusion
Online lecture Via Zoom in Thermodynamics Course Multiple Representation Based Using Geogebra Towards Students' Concept Understanding In The Middle of Physical Distancing Condition (Covid-19 Pandemic)	4,293	1,318	H_0 rejected

Based on the table above and the test criteria above, the t - count is 4.293, while from the list of critical values for the t-test with a significance level of $\alpha = 0.05$ and degrees of freedom (dk) 23, a t- table of 1.318 is obtained. Because at $\alpha = 0.05$ $t_{count} > t_{table}$ ie $4.293 > 1.318$ then H_0 is rejected. Thus, H_1 is accepted which states that there is an influence of online lectures via zoom in the thermodynamics subject based on multiple representations using Geogebra on students' conceptual abilities in the midst of the covid -19 pandemic. This shows that the application of the multiple representation approach using Geogebra can be used as an alternative learning to improve students' understanding of physics

concepts in the covid 19 pandemic. The results of this study are in line with the results of research by (Abdurrahman, Liliyasi, Rusli, & Waldrip, 2015), (Hasbullah et al., 2019) and (Kurniasih et al., 2020) who found that the use of various representations in physics learning was effective for improving students' understanding of concepts.

4. CONCLUSION

1. There are 8 questions based on multiple representations assessments, with each 2 questions for verbal representation, image representation, mathematical representation and graphic representation.
2. The questions developed are good quality. This is indicated by the results of qualitative analysis conducted by experts with an average percentage of the overall assessment of aspects is 86.11%.
3. Students' representational abilities on verbal abilities get an average score of 80.83, drawing skills get an average score of 80.21, math skills get an average score of 77.38 and graphic skills get an average score of 73.21.
4. From the analysis of research data, it was found that the average value of students' conceptual understanding before being given treatment was 42, while the average value of student learning outcomes after being given treatment was 77. After the calculations were carried out for hypothesis testing, it was obtained that t count was 4.293 and t table was 1.318, because t arithmetic $>$ t table that is $4.293 > 1.318$ then H_0 is rejected. Thus H_1 is accepted which states that there is an effect of online lectures via zoom in the thermodynamics subject based on multiple representations using Geogebra on students' conceptual abilities in the midst of the covid -19 pandemic.

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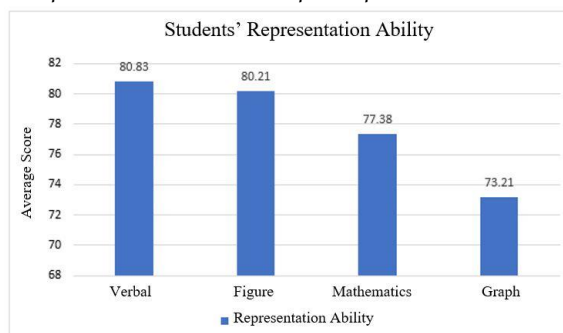
Based on the table of validation results above, the construction aspect is 87.5% with a very good interpretation, the substance aspect is 83.33% with a very good interpretation, the language aspect is 87.5% with a very good interpretation while the average percentage of the overall assessment of aspects is 86.11%.

These results indicate that the multiple-representation-based question instrument viewed from the aspect of substance, construction, and language has a very good interpretation. From these results, it can be stated that the learning assessment tool developed is suitable for use in thermodynamics lectures.

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Graph 4.1 Students' Multiple Representation Ability



Results of Students' Conceptual Understanding

Based on the results of the research, the data obtained from students' conceptual understanding after being given MR-based learning online using Geogebra media. Students' conceptual understanding is obtained by using the results of the pretest and posttest. Data on students' concept understanding can be seen in the following table:

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Testing Requirements Analysis

In this study, the analysis requirements test used was the normality test and the homogeneity test.

a. Normality test

The normality test used for the experimental class was the Lilliefors test for the estimated error at a significant level = 0.05 with the following hypothesis:

H_0 : Data is normally distributed

H_1 : Data is not normally distributed

Accept H_0 If $L_{count} < L_{table}$, the data is normally distributed

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The homogeneity test used in this study was the Bartlett test at a significant level = 0.05 with the following hypothesis:

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Class	N	χ^2_{count}	χ^2_{table}	Conclusion
Experiment	24	9,239	12,592	Homogeneous

Based on the table and the test criteria above, the value of χ^2_{count} is 9.239 , while the price of χ^2_{table} is at $\alpha = 0.05$ with $dk = 6$ which is 12.592 . Thus $\chi^2_{count} < \chi^2_{table}$ that is $9,239 < 12,592$ so accept H_0 . The results of this test can be concluded that the grouping of posttest data on pretest has a homogeneous variance.

Hypothesis testing

Then in order to see the effect formed by X (pretest) on Y (posttest), it is necessary to test the hypothesis. In testing the hypothesis, the t-test formula is used at the significant level $\alpha = 0.05$ and $\alpha = 0.01$ and degrees of freedom (dk) 24 with the following hypothesis:

H_0 : There is no influence of online lectures via zoom in the thermodynamics subject based on multiple representations using Geogebra on students' conceptual skills in the midst of the covid-19 pandemic.

H_1 : There is an influence of online lectures via zoom in the Thermodynamics subject based on multiple representations using Geogebra on students' conceptual skills in the midst of the covid-19 pandemic.

Reject H_0 if $t_{count} > t_{table}$, there is an influence of online lectures via zoom in a thermodynamics course based on multiple representations using Geogebra on students' conceptual abilities in the midst of the covid-19 pandemic.

Accept H_0 if $t_{count} < t_{table}$, there is no influence of online lectures via zoom in the thermodynamics subject based on multiple representations using Geogebra on students' conceptual abilities in the midst of the covid-19 pandemic.

Table 5 . Hypothesis Testing Results (t-test)

Variable	t_{count}	t_{table} $\alpha = 0,05$	Conclusion
Online lecture Via Zoom in Thermodynamics Course Multiple Representation Based Using Geogebra Towards Students' Concept Understanding In The Middle of Physical Distancing Condition (Covid-19 Pandemic)	4,293	1,318	H_0 rejected

Based on the table above and the test criteria above, the t - count is 4.293, while from the list of critical values for the t-test with a significance level of $\alpha = 0.05$ and degrees of freedom (dk) 23, a t- table of 1.318 is obtained. Because at $\alpha = 0.05$ $t_{count} > t_{table}$ ie $4.293 > 1.318$ then H_0 is rejected. Thus, H_1 is accepted which states that there is an influence of online lectures via zoom in the thermodynamics subject based on multiple representations using Geogebra on students' conceptual abilities in the midst of the covid -19 pandemic. This shows that the application of the multiple representation approach using Geogebra can be used as an alternative learning to improve students' understanding of physics

concepts in the covid 19 pandemic. The results of this study are in line with the results of research by (Abdurrahman, Liliyasi, Rusli, & Waldrip, 2015), (Hasbullah et al., 2019) and (Kurniasih et al., 2020) who found that the use of various representations in physics learning was effective for improving students' understanding of concepts.

4. CONCLUSION

1. There are 8 questions based on multiple representations assessments, with each 2 questions for verbal representation, image representation, mathematical representation and graphic representation.
2. The questions developed are good quality. This is indicated by the results of qualitative analysis conducted by experts with an average percentage of the overall assessment of aspects is 86.11%.
3. Students' representational abilities on verbal abilities get an average score of 80.83, drawing skills get an average score of 80.21, math skills get an average score of 77.38 and graphic skills get an average score of 73.21.
4. From the analysis of research data, it was found that the average value of students' conceptual understanding before being given treatment was 42, while the average value of student learning outcomes after being given treatment was 77. After the calculations were carried out for hypothesis testing, it was obtained that t count was 4.293 and t table was 1.318, because t arithmetic $>$ t table that is $4.293 > 1.318$ then H_0 is rejected. Thus H_1 is accepted which states that there is an effect of online lectures via zoom in the thermodynamics subject based on multiple representations using Geogebra on students' conceptual abilities in the midst of the covid -19 pandemic.

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