

# Graphical Representation Skills in Online Learning During COVID-19 Pandemic Through Augmented Reality Assisted Student Worksheets

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## ABSTRACT

This study aims to determine the student's graphical representation skill in online learning through Augmented Reality Assisted student worksheets in Simple Harmonics Motion during COVID-19 pandemic. This study is quasi experiment using Post-test Control Group Design. The population is all students of X grade in SMA Negeri 1 Kalasan. The sampling technique used was simple random sampling. The sample in the study was X MIPA 1 as experimental class and X MIPA 3 as control class. Assessment of graphical representation skill was obtained by giving essay questions. There are three indicators of the graphical representation skill that are measured, namely, the student's ability to find the spring's constant from the F-x graph, student's ability to analyses the order of spring's constant from largest to smallest based on the slope and student's ability to find a spring's displacement when the force is changed based on the graph. The analysis used is descriptive statistics to determine the mean value, standard deviation, standard error mean and independent sample T test. It can be concluded that there is no significant difference between experiment class and control class based on the student's graphical representation skill in online learning during COVID-19 pandemic.

**Keywords:** *Graphical representation, Online learning, COVID-19, Augmented reality, Student worksheets*

## 1. INTRODUCTION

An unknown disease was first found in China and reported to WHO on 31 December 2019. WHO declared this disease as an international emergency on January 2020. They named it as COVID-19 (Coronavirus Disease-2019) on February 2020. COVID-19 is a very infectious disease caused by SARS-CoV-2. In February 2020, it has been reported in almost all continents in the world. Nowadays, there are more than 200 countries infected. As for now, there is no currently vaccine to protect against COVID-19. Scientist still studying to know whether COVID-19 behave more like SARS and then eventually disappear or will remain ongoing like MERS[1]. The world was hoping expectantly for safe and effective vaccines.

The outbreak of this virus is so rapid that it infects people of Indonesia. The possibility of pandemic

period in Indonesia is approximately on August 2020 [2] but until now the positive case confirmed keep rising every day. By the time this article was written, Indonesia had 1,288,833 cases, 34,691 deaths, 1,096,994 recovered and 157,148 active cases (<https://www.worldometers.info/coronavirus/country/indonesia/>).

This gives impact on Indonesian education system as well. Indonesian government need to limit student's activities, teaching activities and schools is running by work from home. In order to reduce the number of COVID-19 cases, Indonesian Educational and Cultural Ministry, govern that National Examination 2020 to be cancelled and learning activities to be conducted using online learning. This impact every schools conduct the learning process using e-learning application such as Google classroom, Zoom and Google Meet to reduce the risk of COVID-19[3]. This

policy applied to every schools in Indonesia including Yogyakarta city.

Teaching physics concept during COVID-19 pandemic, such as Simple Harmonic Motion (SHM), is somewhat difficult. Therefore, learning media is needed to help student learn SHM. Several learning media have already been developed such as Logger Pro [4], Oscillator Digital Detector (ODD) [5] and damped oscillation simulation [6]. Not only learning media but also the multi representation skill. Because describing physical phenomena verbally is not enough. It needs another approach to explain a phenomenon. In physics education, representation is very important to explain such concepts. Common type of representation used in class to explain physics theories and laws are text, symbols, graphs, pictures and even gestures [7]. If these abilities are weak then the student might be experience misconception. The more student understands representations the more they understand science.

Multiple representation is used to represent the same concept with different format [8]. In the process of learning, students with richer representation gives more effective result and two representation are better than one representation [9]. There are three main function of multiple representation. The first is complementary information. The second is to constrain the possibility of student's misinterpretation. The third is to encourage students to construct more understanding [10]. Multiple representation can also be used to solve many physics problem such as thermodynamics [11], electricity and magnetism [12] because a problem can be solved in many strategies not only using mathematical strategy but also different representation of information, such as graphical representation.

In physics more than one representational format is used to retrieve information and support knowledge construction [8] such as graphical representation. In physics learning, student must be skilled at making and interpreting a graph [13] because it is useful for summarizing sets of data, obtaining and interpreting complex data. Graphical representation is concern in making graphs of mathematical formulas [14]. Although graphs are so important, studies in Indonesia indicate that students still have problems in using and constructing graphical representation [[15]. Some studies in Indonesia indicate that students' graphing skill is need to be improved. The study shows that student's representation skill of verbal, image, mathematical, and graphical are still very low [14]. Students have difficulties in solving physics problems related to graphical representation [16]. Graphic

interpretation skill of pre-service physics teachers are still inadequate [13].

Learning physics, in general, might be an uninteresting and boring activities, especially when the materials are difficult to understand. This make students less motivated to learn Physics. Many methods have been developed to change the learning activities become more fun, interesting and enjoyable [17]. This study proposed new learning activities by applying Augmented Reality (AR) in Simple Harmonic Motion (SHM). Thomas Caudell and David Mizell were the first researcher coined the term "augmented reality" in 1990 [18] but only the advent of Pokemon Go gave the world's attention [19]. Based on this game, we now know that this technology can be applied to various domain in real life, including education domain.

Many studies have revealed positive effect of AR for educational purposes, such as, understanding gas properties [20], AR in computing education[21], AR as e-learning tool [22], immediate-action commander training [23], mechanical drawing [24], rail transportation[17] and modelling of human heart [25]. Based on these studies AR is very useful in educating student [26] such as increasing students' achievement and visual thinking [27], promoting collaborative and autonomous learning [28], increasing academic achievement and motivation of student [25] and increasing the interest in learning [13]. Therefore, AR technology is worth to be used in education domain.

## 2. RESEARCH METHOD

This study was a quasi-experiment using Post-test Only Control Group Design. The population in this study was 60 students of X grade SMAN 1 Kalasan, Yogyakarta.. The sampling technique used was simple random sampling. X MIPA 1 as experiment class and X MIPA 3 as control class. There were 30 students in each class. The analysis of hypothesis test was using independent sample T test to determine whether there is a significant difference between two classes or not. Learning process is carried out using Google Classroom. Table 1 show the study design.

**Table 1.** Posttest Only Control Group Design.

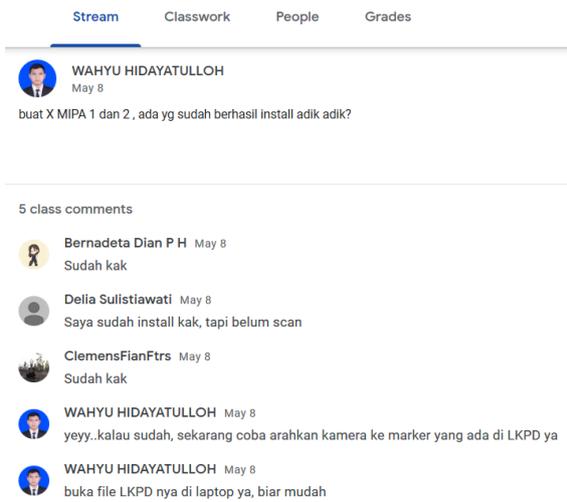
Class	Treatment	Posttest
Experiment	X	O <sub>1</sub>
Control		O <sub>2</sub>

The AR installer file is uploaded to google drive first and then students downloaded and installed it in their Android smartphone. After installing then

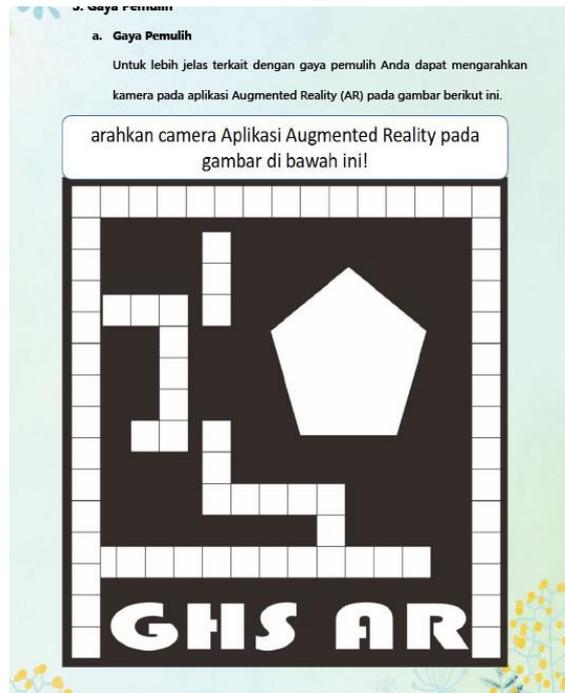
student can run it along with the student worksheets. There were three indicators of the graphical representation skill that are measured, namely, the student's ability to find the spring's constant from the F-x graph, student's ability to analyses the order of spring's constant from largest to smallest based on the slope and student's ability to find a spring's displacement when the force is changed based on the graph.

**3. RESULT AND DISCUSSION**

This study aims to determine graphical representation skill of student between experiment class which is taught using Augmented Reality-Assisted student worksheets and control class which is taught using regular learning. The learning process is carried on using Google Classroom as shown in Figure 1. As for the AR to work properly students have to install the application installer and then run it by scanning the marker in the student worksheet as shown in Figure 2.

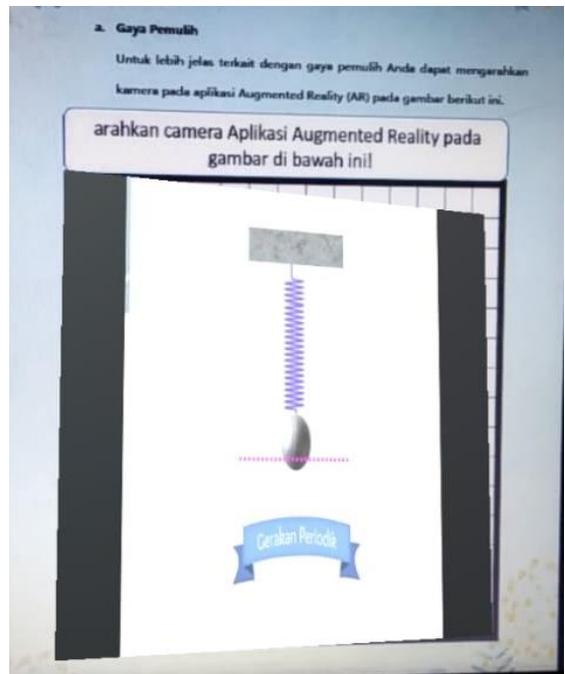


**Figure 1** Google Classroom Learning



**Figure 2** Marker in student worksheet.

After scanning the marker, student will see that there will be an AR video coming out from marker. The video is describing the SHM material as shown in Figure 3.



**Figure 3** The AR video coming out from the marker.

There are three graphical representation problems that student needs to solve. Figure 4, 5 and 6 show the first, second third problem respectively.

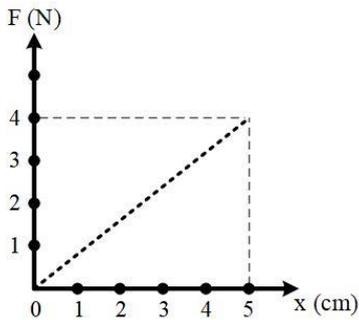


Figure 4. Problem 1

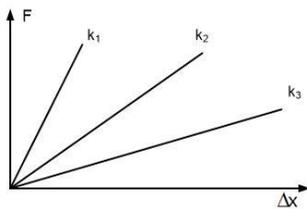


Figure 5. Problem 2

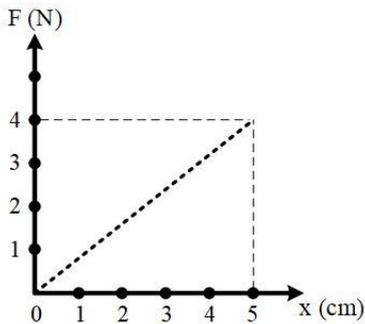


Figure 6 Problem 3

In the first problem, it is given a problem related to force and displacement of the spring. Student need to find the spring's constant based on the information given by the graph. Common mistake by student is that students tend to forget to convert the unit in the x axis. This little mistake could make a huge problem. Based on this finding teacher should remind the students not to forget to convert the unit to SI first. Figure 4 show that the value force is 4 N and the displacement is 5 cm. In this problem students have to convert the unit of displacement to SI unit to get the correct answer. Figure 7 show the student's mistake by not converting to SI unit. Meanwhile, Figure 8 show student's answer not only giving the correct answer but also solving problem systematically.

$$k = \frac{F}{x}$$

$$k = \frac{4}{5}$$

$$k = 0,8$$

Figure 7. Student's incorrect answer.

Diketahui :

$F(N) = 4$ , maka  $\Delta(x) = 5 \text{ cm} = 0,05 \text{ m}$

Ditanya :

nilai konstanta pegas

Jawab :

$$F = k \cdot \Delta x$$

$$k = \frac{F}{\Delta x} = \frac{4 \text{ N}}{0,05 \text{ m}}$$

$$k = 80 \text{ N/m}$$

Figure 8 Student's correct answer.

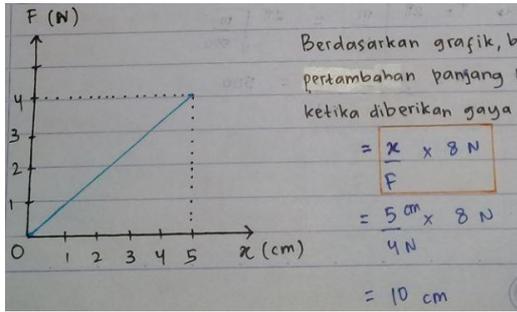
In the second problem, it is given a graph contains three lines. Each line is representing the spring's constant,  $k_1$ ,  $k_2$  and  $k_3$ . Student need to find the order of  $k$  from the smallest  $k$  to the biggest  $k$ . In this case, student doesn't need to find the gradient in each case but they need to understand that when the line is getting closer to x-axis it's gradient would be decrease. In this case students have to understand that the value of spring's constant,  $k$ , from the smallest to the biggest are  $k_3$ ,  $k_2$  and  $k_1$ . Figure 9 show one of the student's answers.

Grafik yang menunjukkan konstanta dan yg terkecil  
 $k_3 ; k_2 ; k_1$

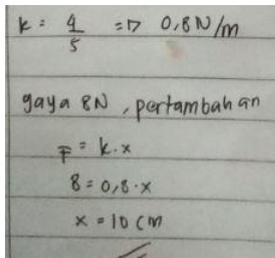
Figure 9 Student's answer on the problem 2.

In the third problem, students have to find the displacement  $x$  when the force is 8 N. There are several ways students used to solve the problem. First, students have to find the gradient based on graph and then use the Hooke's Law to solve it. Second, the fastest way is using the comparison of  $F/x$ . Figure 10, 11 and 12 show some of the student's answers.

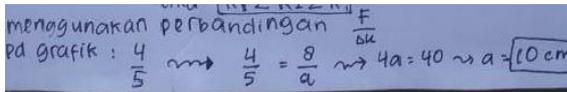
**Figure 10.** Final answer is correct but there is a mistake in using Hooke's Law.



**Figure 11.** The final answer is correct but the process of finding spring's constant is incorrect.



**Figure 12.** Final answer and the solving problem are correct.



In this case, the mistake made by some students are the same as first problem. They tend to forget to convert the unit of displacement  $x$  to SI unit. This simple tiny mistake causes big problem in finding the answer. Even if the final answer is correct (Figure 10 and Figure 11) teacher should not let this habit to keep happening in the future. After collecting student's answer, using SPSS we can determine the descriptive statistics of experiment and control class. Table 2 show the group statistics.

**Table 2.** Group statistics

Class	N	Mean	Std. Deviation	Std. Error Mean
Exp	30	79.33	8.872	1.620
Control	30	74.77	6.585	1.202

Next, we compare the means of two classes using Independent sample T test. The null hypothesis in the study was there is no mean difference between two

classes and the alternative hypothesis was the mean of the two classes are difference. Table 3 show the output of Independent sample T test.

**Table 3.** Independent sample T test.

	Levene's Test for Equality of Variances		t-test for Equality of Means	
	F	Sig.	T	Df
Equal variances assumed	3.426	0.069	2.264	58
Equal variances not assumed			2.264	53.511

F is the test statistics of Lavene's test which is 3.426, the significance value or the p-value is 0.069 and the t value is 2.264. Since p- value is greater than 0.05, we cannot reject the null hypothesis. It means that there was no significant difference between experiment and control class.

AR technology, in the context of natural science education such as Physics is good, applicable and useful [29]. AR technology could bring a virtual world into a real world. Therefore, AR technology is very suitable to be used in the learning process [30]. Not only suitable for teaching student with no disability but also suitable for teaching student with mental disabilities [31]. AR technology could make learning process to be more amazing and meaningful [32]. However, there are obstacles that student and teacher experience in applying AR. First, cost of implementing AR technology is relatively high. Second, the lack of quality graphics that could affect student's visual perception. Third, hardware limitation [33] because the apk file of AR application is about 70 MB.

As the research was conducted, the result show that there is no significance difference between experiment and control class. This happened because of the limitations in the study. First, the learning process was conducted through online learning. Study show that online learning has several weaknesses such as some student has poor internet connection and spend much data, students cannot fully understand the material, student cannot discuss freely with friends and many students prefer discuss with teacher directly face to face [34]. Second, student's lack of digital literacy skill associated with AR technology. Some student still didn't understand how to download the installer, how to install it in their smartphone and how to operate

the AR application. Third, the time management that is less effective [35]. The learning process using AR Assisted student worksheet only take one hour due to time limitation rule from government and that makes the learning process is less effective.

#### 4. CONCLUSION

After conducting the study, it can be concluded that there was no significance difference in student's graphical representation skill between experiment and control class using Augmented Reality Assisted student worksheet in online learning during the COVID -19 pandemic.

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