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Analysis of Student Practical using *Logger Pro* to Improve Graphic Representation of Harmonic Oscillation Material

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Abstract

This study aims to analyze the activities of computational practicum using logger pro software to improve student graphic representation in understanding the oscillation material. The sample are 35 students of class X Mipa 3 SMA 1 Bae in 2016/2017 decided by purposive sampling technique. The research instrument is a harmonic oscillation sheet and a description test that measures the ability of graphical representation. The research method used mixed method with concurent embeded design. Analysis of research data using comparative test t paired sample test and N - Gain test of student scores. Students found some synchronous oscillation characteristics between the results of the lab and the results of the analysis of six graphs from the plot logger pro. The results of pretest and post-test average score are respectively 20.85 and 43.73. Description of comparative test statistic yields tcount> ttable which means there is significant difference between pre-test and post-test value data, and N-Gain test is 0.29 which means there is increasing value in low category. It shows computational activity using logger pro, effectively improving students' ability in multiple graph representations to understand the characteristics of harmonic oscillations.

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INTRODUCTION

The study of several physics education research shows that the process of computer-aided multimedia learning effectively improves the representation of material mastery. PhET software is an interactive computer simulation to teach students the concept of physics materials such as visually represent abstract concepts and microscopic processes of quantum mechanics that can not be observed directly, conducting dynamic electrical experiments, optical devices and several other physics simulations (McKagan, 2008; Sinulingga, 2016; Prihatiningtyas, 2013). Furthermore, the use of scratch software also has a function for computational modeling in physical materials, such as visual representation of falling object motions which have different velocities over time, observations of changes in the momentum of objects that are difficult to visualize directly, and motion picture images of abstract material kinetic material theories (Lopez, 2015; Serevina, 2017; Martanti, 2013). The visual representation of theoretical physics through computer software makes it easier for students to learn physics concepts. Understanding concepts, initial knowledge, and practice are very influential on multirepresentation accuracy such as mathematical representation, diagrams, graphs and vebal (Hau, 2017).

Study studies assisted computing program supports modeling visual representation of physics theory one of them in improving understanding of graphical representation that still low and need expansion of research. Graphical representation is an important fundamental skill for students in their lives as it serves to understand and communicate the information presented in the graph (Glazer et al., 2011). Graphs in physics are used to present observational data, inform phenomena and show relationships between variables and magnetic quantities (Mustain, 2012).

The relationship between displacement graph and speed over time facilitates understanding of the concept of motion of an object because it can be used to describe differential and integral to find the mathematical equations of the displacement as well as the speed (Berry, 2003). In addition, the business value can also be obtained from the width of the graph of the force relationship to displacement (Nguyen, 2011). The correct interpretation of the meaning of the graph improves students' understanding mathematically.

Physical graphical representation research studies emphasize more on the understanding of linear graphs in the chapter of kinematics of motion. The results showed that students had difficulty interpreting the direction of motion of objects from the linear graph analysis relationship between distance and time (Bollen, 2016). In addition, most of students experience errors in interpreting the slopes of the slope graph of distance or speed over time (Billings, 2000). Interpretation of kinematics charts is one of the difficult capabilities that not only experienced by students but also occurs in physics teacher prospective students (Subali, 2015).

Based on the results of research the use of technology helps translate between graphical representation and algebra, such as using mathematical and geometry software such as Coypu, Drive GeoGebra or Sketcpad (Birgin et al, 2012). The use of PAKMA program in learning has been proven to assist students' effectiveness in understanding position graph, speed and acceleration of time, because it can simulate the movement phenomenon to form dynamic graphical visualization (Ploetzner et al, 2009). In addition, the use of modellus software also proves a contribution in helping students improve the graph interpretation of displacements, kecepatam and acceleration of the time of the case of motion ball in 1 dimension (Araujo, 2008).

Logger pro software as one of the media that can represent the graphics of the motion of objects, such as helping students read linear graphics position against time with the slope of the graph shows the speed of the object (Smith, 2013). In addition, the success of *logger pro* software when used in analyzing spring system harmonic motion can result in plot deviation, speed, acceleration, and energy graphs (Asbanu, 2016).

The need for the development of research on the study of graphical representations in addition to linear graphics, one of which is a harmonic function graphic representation to help students understand the characteristics of vibration. The purpose of this research is to analyze the activity of vibration practicum computationally using software *logger pro* so as to produce graph plot which function to improve the graphical representation of linear function and harmonic function of students in understanding the vibration material.

METHOD

The study was conducted with 35 students of class X Mipa 3 SMA 1 Bae Kudus academic year 2016/2017. The sampling of the research was done by purposive sampling technique. The research method used mix method with concurrent embedded design. The pre-test and post-test values measure the ability of graphical representation of linear function and harmonic function graph of harmonic vibration system material with graph representation indicator covering seven component of chart graph. According to Zhang (2010), the seven graphical literacy components include graphic production skills, graphical representation of ideas, source information, captions, revision and aesthetics. The research instrument used the student practicum sheet and the test questions that have been tested for validity. The results of the pre-test and post-test values are based on values before and after the treatment of students on the activities of computational practicum in analyzing harmonic vibration video recording using *logger pro* software. The effectiveness of treatment-assisted media *logger pro* is seen from comparative test result of t-paired sample test and N-gain enhancement test using SPSS version 20 software. Comparative test selection is based on test data of pre-test and post-test with normal test using test one sample test Kolmogorov-Smirnov test on SPSS version 20 software.

RESULT AND DISCUSSION

The question of pre-test and post test in the research aims to measure students' graphical representation ability in understanding the harmonic oscillation material. Overall, the post-test average score is superior to the pre test result with the highest pre test score of 35.7 and the post test of 71.60 shown in Table 1

Table 1. Graphic Representation Capability Value in understanding harmonic oscillation material

Description	***Pre test***	***Post test***
Highest Value	35.78	71.60
Lowest Value	7.25	29.48
Average	20.85	43.73

A series of learning activities in understanding harmonic motion through graphical representation of media-assisted *logger pro* improves student's score as shown in Table 1. The series of learning includes practicum of vibration of mass spring system and swing pendulum, computational activity from videotape of practicum vibration using media *logger pro* and discussion activities from practical and computational analysis.

Activity of harmonic oscillation involves 3 types of oscillation variation, such as harmonic oscillation with variation of amplitude, harmonic oscillation of spring system with variation of load mass, and harmonic oscillation of pendulum system with variation of rope length. The overall average student observation result from practicum activity with 3 variations of oscillation is shown Table 2 until Table 4.

Table 2. The result of the period and frequency of oscillation variation of amplitude

No	Amplitudo (cm)	Waktu (s)	Periode (T) = $\frac{t}{n}$	Frekuensi (f) = $\frac{n}{t}$
1.	5	10	$\frac{10}{15} = 0{,}67\ s$	$\frac{15}{10} = 1{,}5\ Hz$
		10	$\frac{10}{15} = 0{,}67\ s$	$\frac{15}{10} = 1{,}5\ Hz$
2.	10	10	$\frac{10}{15} = 0{,}67\ s$	$\frac{15}{10} = 1{,}5\ Hz$
		10	$\frac{10}{15} = 0{,}67\ s$	$\frac{15}{10} = 1{,}5\ Hz$

Table 3. The result of the period and frequency of oscillation variation of spring-hunged mass

No	Massa (gram)	Waktu (s)	Periode (T) = $\frac{t}{n}$	Frekuensi (f) = $\frac{n}{t}$
1.	100	24	$\frac{24}{15} = 1{,}6\ s$	$\frac{15}{24} = 0{,}625\ Hz$
		22	$\frac{22}{15} = 1{,}5\ s$	$\frac{15}{22} = 0{,}681\ Hz$
2.	150	27	$\frac{27}{15} = 1{,}8\ s$	$\frac{15}{27} = 0{,}56\ Hz$
		27	$\frac{27}{15} = 1{,}8\ s$	$\frac{15}{27} = 0{,}56\ Hz$

Table 4. The result of the period and frequency of oscillation variation in the length of the pendulum swing

No	Panjang tali (cm)	Waktu (s)	Periode (T) = $\frac{t}{n}$	Frekuensi (f) = $\frac{n}{t}$
1.	40	21,72	$\frac{21{,}72}{15} = 1{,}44\ s$	$\frac{15}{21{,}72} = 0{,}69\ Hz$
		21,81	$\frac{21{,}81}{15} = 1{,}45\ s$	$\frac{15}{21{,}81} = 0{,}68\ Hz$
2.	60	25,49	$\frac{25{,}49}{15} = 1{,}69\ s$	$\frac{15}{25{,}49} = 0{,}58\ Hz$
		24,33	$\frac{24{,}33}{15} = 1{,}62\ s$	$\frac{15}{24{,}33} = 0{,}61\ Hz$

Based on Table 5, from the observation and the practicum discussion sheet, the students were able to conclude according to the theory that the amplitude did not affect the period or frequency, the mass suspended on the spring and the length of the pendulum swing affect the period and frequency. The results of student conclusions are not accompanied by reason, just reading the observations only and not able to explain the relationship in theory. It shows that the average student has not understood the meaning or even not read the theory before the practicum implementation to determine the period or frequency of oscillation in each spring system that depends on the mass and pendulum swing system that depends on the length of the rope. During the discussion, students stated that the formula of period and frequency is a new formula for the students of class X, because the previous students while sitting in junior high school (SMP) only to find the period or frequency of time and the amount of oscillations that have been calculated.

Based on Table 6, students perform computational activities with media logger pro that aims to analyze oscillation characteristics through the plot view of logger pro graphs to find the value of period, frequency and even deviation, speed, acceleration, and mechanical energy of video recording of all three types of practicum of oscillation already performed previous. The result of the computational activity of harmonic oscillation variation of amplitude using logger pro produces 6 graphs shown Figure 1. The result of each harmonic oscillation analysis with a certain variation yields six graph plots, including the deviation graph, speed, time acceleration, kinetic energy graph & potential energy to deviation and the style graph of the deviation.

Based on the results of computational *logger pro* activities such as Figure 1, the students found the characteristic of the period and the oscillation frequency of the deviation / speed / acceleration plot graph over the time shown Table 7. The results of the analysis of period and frequency values practically and computation close to the same. It indicates that students are able to determine the period or frequency of the harmonic graph representation. However, from the discussion answer sheet, students have not been able to read and describe the relationship between the deviation graph, speed, time acceleration and kinetic energy graph, potential energy to concurrent inferred intersections such as Table 8 & 9.

Table 5. Results Description Activity of Practicum Harmonic Oscillation System

Harmonic Oscillation Practicum	**Hasil**
Variation of amplitude	• All groups obtained results of period and frequency data with close to fixed values for each variation of 5cm and 10cm amplitude for 15 times the oscillation • The student discussion results can be concluded if the amplitude does not affect the frequency or period, but can not give the reason for the conclusion
Spring system with load mass variation	• Some groups can obtain an increasing amount of time for 15 times the oscillations of an increasing mass of 100g and 150g. • Several groups of discussion results conclude if the mass of the larger load produces an increasingly large period and the frequency is smaller, but it can not give a reason why it can happen
Swing system pendulum with variation of rope length	• All groups gain an increasing amount of time for 15 times the oscillation of the length of the pendulum swing rope of 40cm and 60cm • Students can only conclude that the larger the length of the rope on the swing will result in greater time, but does not offend the long relationship of the rope to the period or frequency.

In addition, the results of drawing the students shown Figure 2 from the prologue plot of the *logger pro* graph shows students only imitate the form of graphs displayed *logger pro*, regardless of the relationship and meaning between the variables that make up the graph. Students' difficulties in drawing graphs include the difficulty of analyzing data, the difficulty of determining variable-scale intervals, to the difficulty of establishing an initial deviation point when drawing (Dewi, 2017). Students understand correctly from the results of reading and drawing graphs after getting an explanation during the discussion together in class. The result of graphical display with media *logger pro* facilitate in the process of understanding the material of harmonic oscillation during discussion. From the results of the *logger pro* students can watch a repetitive motion and look at the representation graph so as to help students overcome common obstacles when interpreting the graph (Smith, 2013).

Table 6. Computational Activities with *Logger pro* media

Harmonic Oscillation Practicum	**Variation of Amplitude**	**Variations of Load Mass**	**Variation of Rope Length**
General description	Running the *logger pro* app by inserting a mass-wave mass-system oscillational video (Y), then identifying each motion with the mouse to take the position of the deviation (Y) over time simultaneously on the 5m and 10cm amplitude	Running aplication *logger pro* by inserting the oscillation video of the mass spring swing system that has the vertical sideways (Y), then identifying each motion with the mouse to take the position of the deviation (Y) over time simultaneously at a	Running the *logger pro* application by entering the oscillation video of the pendulum system which has the horizontal sideways (X), then identifying each motion with the mouse to mengambiil the position of deviation (X) over time

	variations	mass variation of 100g and 150g.	simultaneously on variations of 40cm and 60cm rope length variation
Purpose	• Students are able to find the oscillation characteristics for each variation through time deviation harmonic deviation graph, time velocity, time acceleration and linear function linearity graph to deviation, energy graph of deviation from result of plot *logger pro* • Students are able to draw graphs manually and know the meaning of oscillation characteristics after viewing and identifying the result plot *logger pro* chart		
Difficulty learning	• Based on the pre test results, students' understanding is very low on the process of reading and drawing graphs		
Statement Activity	a. Compare the characteristics of oscillation include period, frequency and angular velocity of each oscillation variation of amplitude, load mass and length of rope between the result of graph plot of application *logger pro* and result of data of result of lab work manually b. Identify the meanings of each time from the plot of deviation, speed, simultaneous acceleration, mechanical energy graph and acceleration graph of deviation c. Draw graphically manually on the discussion sheet paper		

Based on the results of the learning activities, the ability of graphical representation of harmonic vibration material becomes better after going through a series of process lab, computation analysis and discussion together. Graphical representation capabilities include drawing and reading charts.

Logger pro software plays a role in improving the graphic representation seen from (a)the ability of the students to determine the location, name, and unit of the graph constituent variables when answering the post test problem, since the determination of the graph variable as one of the main stages to generate the *logger pro* graph plot, (b) the students found the reference source to draw the graph correctly from the result of the plot *logger pro* so that the graphic results of the harmonic function of the students getting better and closer to theoretically correct, (c) the students can better interpret the meaning of the harmonic function graph, because with the software *logger pro* can be used to track the change of each of the graph constituent variables so that students can compare and infer the characteristics of the vibration charts, (d) the students find it easier to grasp the teacher's explanation of the meaning of the graph because the results of the graph and video plots analyzed can be displayed simultaneously. The result of better student graphic representation corresponds to the seven components of graphical literacy (Zhang, 2010)

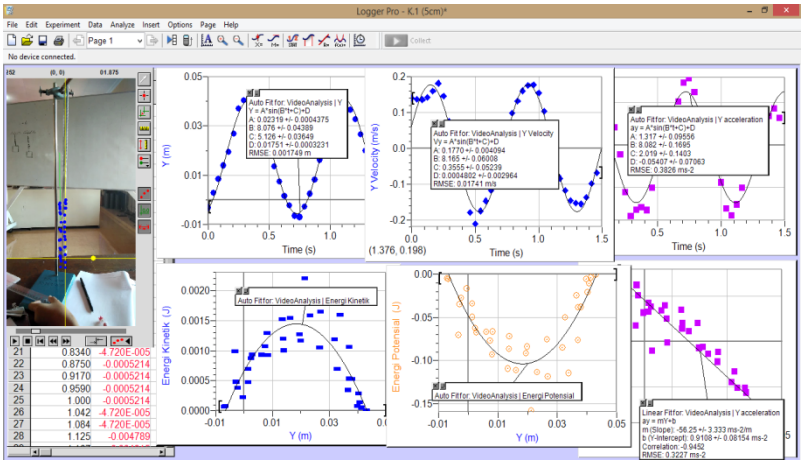

Figure 1. Graph of result of analysis of computational activity of harmonic oscillation video of amplitude variation using media *logger pro*

Table 7. The result of characteristic analysis of period & frequency oscillation variation of amplitude of *logger pro* graph plot

A	Grafik	Persamaan	ω	Periode ($T=\frac{2\pi}{\omega}$)	Frek ($f=\frac{\omega}{2\pi}$)
5 cm	Simpangan terhadap waktu	Y= A sin (Bt+C)+D	9,4 rad/s	0,67 s	1,5 Hz
	Kecepatan terhadap waktu	V=A ω cos(ωt)	9,4 rad/s	0,67 s	1,5 Hz
	Percepatan terhadap waktu	a= -ω^2 Asin(ωt)	9,4 rad/s	0,67 s	1,5 Hz
10 cm	Simpangan terhadap waktu	Y= A sin (ωt)	9,4 rad/s	0,67 s	1,5 Hz
	Kecepatan terhadap waktu	V= A ω cos(ωt)	9,4 rad/s	0,67 s	1,5 Hz
	Percepatan terhadap waktu	a= -ω^2 Asin(ωt)	9,4 rad/s	0,67 s	1,5 Hz

Table 8. Errors describe the relationship graph deviation, velocity, and acceleration of time

A (m)	Simpangan (m)	Kecepatan (m/s)	Percepatan (m/s^2)
0.05	$A_{maksimum}$	0,1542	0,1561
	Kesetimbangan	0	0
	$A_{minimum}$	-0,0003667	-0,001906
0,10	$A_{maksimum}$	5,114	0,5590
	Kesetimbangan	0	0
	$A_{minimum}$	-7,038	-0,5590

Table 9. Errors describe the relationship graph kinetic energy and potential energy to deviation

Simpangan (m)	E.Kinetik (J)	E.Potensial (J)	E.Mekanik (J)
$A_{maksimum}$	5,026	0,0012427	5,047
Kesetimbangan	0	0	0
$A_{minimum}$	-5,206	-0,0012427	-5,047

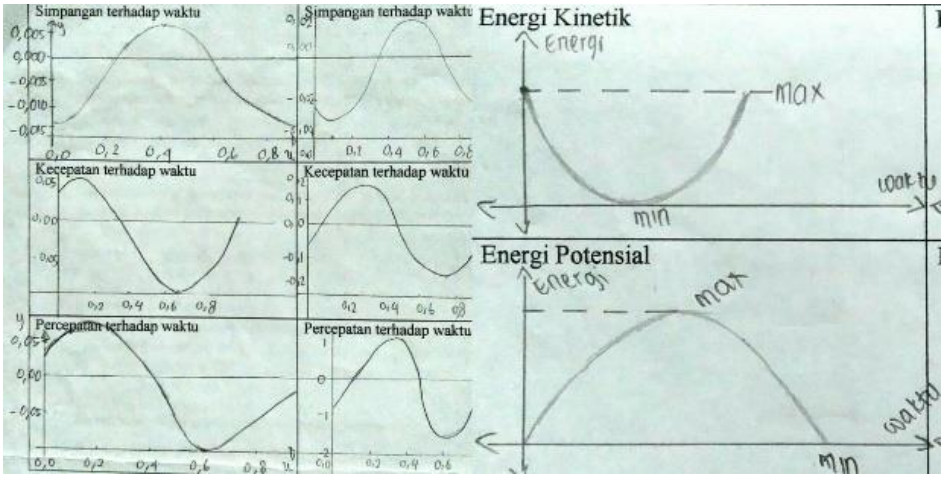

Figure 2. Error drawing results modeled after plot analysis *logger pro*

Furthermore, based on the results of comparative hypothesis test t paired sample test with SPSS software version 20 data pre-test and post-test show normal distribution is shown Table 7 which shows the value of tcount = -14.551. At the significance level α = 5% and df = 34 from the two-party test get the value t_{table} = 2.021. Based on two-party test, the tcount can be interpreted as 14.551, so $t_{test} > t_{table}$, it means that there is significant difference between pre test and post test.

Table 10. T test result paired sample test from pre test and post test data

	Paired Differences					t	df	Sig (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Inteerval of the Difference				
				Lower	Upper			
Pair 1 Pre test – Post test	-22.876	9.301	1.572	-26.071	-19.681	-14.551	34	.000

This indicates that the provision of treatment in the form of learning that emphasizes the ability of logged pro-assisted graph representation to understand the concept of harmonic oscillation material affect the students' understanding so that the value of post test is superior. The results indicate a significant difference from the pre test and post test values, supported by the test (N-gain) which proves that differences occur at a significant increase. The result of N-gain score analysis is descriptive statistically for 35 students shown in Table 11.

Table 8. Descriptive Statistics of N-Gain Data Ability Graph Representation

	N	X_{min}	X_{maks}	$\bar{X}$	S
Skor *N Gain* Kemampuan Representasi Grafik	35	0.10	0.66	0.29	0.11

The result of N-gain test is shown in Table 8 the increase between pre test and post test data occurs in low category, so that the provision of learning treatment supported by *logger pro* media proved to re-affect students' graphical representation ability. An increase in the gain test on the low criterion suggests the vibration practicum analysis using *a pro logger* is potentially good at reminding the student's chart representation.

Based on the results of comparative hypothesis testing and N gain supports that pro-effective media *logger pro* is used to improve students' graphical representation in understanding harmonic oscillation materials. This is in accordance with previous research that the use of media facilitate the understanding of the concept of graphics (Ersoy, 2004).

CONCLUSION

Practicum analysis of vibration system using *logger pro* software effectively improve the graph representation of harmonic vibration material. Improved graphic representation capabilities include drawing and reading graphs in understanding the characteristics of harmonic vibrations. The ability to read and draw harmonic vibrational charts is better after going through a series of practical processes, computational analysis and discussion together.

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