GATA-Fisika: A New Learning Innovation to Help Students Better Understand the Concept of Simple Harmonic Motion

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Keywords: Educational Game, Learning Innovation, Simple Harmonic Motion.

Abstract: The most significant goal of teaching approach is improving students' success in term of their conceptual understanding. The effective learning are very important during the learning process. Meanwhile, most of students think that physics is very difficult to understand. Many researchers have developed any learning strategies. Up to now, multimedia-based teaching approach is claimed as an interesting in teaching physics. However, many reports claim that they were not sufficient due to the lack of students' kinaesthetic aspect. Therefore, we introduce the combination of multimedia technology and Indonesian traditional game as a new physics learning strategy. Our research was conducted in SMAN 9 Malang with the topic of simple harmonic motion (SHM). Our previous observation uncovered that many students faced difficulty in understanding the topic even the basic definition of SHM. The subject in this research was class X-MIA 5 consisting of 28 students. This research design used a mixed method with an embedded experimental design. The chosen traditional game was engklek well packaged combined with some puzzles and quizzes using Macromedia Flash Player. This research showed that GATA-FISIKA could improve the students' understanding of the topic of simple harmonic motion.

1 INTRODUCTION

Simple harmonic motion or abbreviated by SHM is one of the physics topics which is abstract and difficult to understand. According to (Serway and Jewett, 2014), SHM is a reciprocating motion of a certain object to pass the equilibrium point because of restoring force. SHM is essential to be studied since it is a basis to learn any object motions disturbed from the equilibrium position, either the macroscopic wave phenomena to quantum phenomena. According to (Parnafes, 2010), SHM is significant not only in the physics field but the other natural science field as well as technical engineering. Besides, SHM is fatherly beneficial for the life running 21st century namely to estimate walking distance for waist-mounted PDR, to develop backward wave oscillation (BWOs), and to develop mechanism for length-dependent regulation of muscle active tension (Earley, 1991; Lan and Shih, 2012; Amin, Saber and Sagor, 2015).

The significance of SHM demands the student to not only know but also understand the concept of SHM. Uunderstanding a concept is one of the essential goals in learning. The good conceptual understanding is the basis to develop the concept and connect the concepts so that they can be used to solve the problems in daily life (Jumadin, Hidayat and Sutopo, 2017). Moreover, the understanding of SHM is deeply needed to facilitate the students in applying SHM in the daily life (Sugara and Yeyehn, 2016).

However, the essence of SHM is not in line with the students' understanding of the SHM topic. Some research results showed the students' low understanding of SHM (Sufahmi and Safitri, 2017). The research of (Haryono, 2017) on the students of class X SMA Negeri 2 Yogyakarta resulted that 57.16% of the students did not understand, 21.79% of them partly understood, 19.36% of them understood, and 2.47% of them underwent misconception of SHM. This result was supported by another research result showing the students' understanding of the

Andani, R., Sholihah, B., Hidayat, N., Navis, I. and Yulianti, E.
GATA-Fisika: A New Learning Innovation to Help Students Better Understand the Concept of Simple Harmonic Motion.
DOI: 10.5220/0008412003450350
In *Proceedings of the 2nd International Conference on Learning Innovation (ICLI 2018)*, pages 345-350
ISBN: 978-989-758-391-9

SHM topic was 28.21 categorized as low (Aprilia, Syuhendri and Andriani, 2015).

That misconception caused the students difficult in understanding some concepts, misconception of SHM equation of 92.56%, the period of spring system of 79.65%, frequency and SHM period of 50% and the restoring force of 40.31% (Haryono, 2017). The research conducted by (Aprilia, Syuhendri and Andriani, 2015) showed that there was a misconception of velocity, acceleration, force, energy, and effort of the spring. Furthermore, the research results indicated that the students were confused with the relationship of mass and the rope length to the pendulum period (Husniyah, Yuliati and Mufti, 2016).

Such misconception happens due to the less optimum learning in the class. Some research mentioned that the less optimum learning was caused by the teacher less variously and creatively teaching and less appropriately choosing the teaching method (Liliawati and Ramalis, 2008; Widyaningrum, Sarwanto and Karyanto, 2013). Another research mentioned that the students' misconception was because the students were less interested in the topic being taught (Sakti, 2013).

Based on the above explanation, students need good and appropriate learning. The good learning should involve the students actively (Jumadin, Hidayat and Sutopo, 2017). According to (Widyaningrum, Sarwanto and Karyanto, 2013), the good learning is a learning using the proper model and media. The good learning is pleasant and can improve the students' passion for learning (Siagian, 2015).

Therefore, model and media, that follow the development of the era and improve the students' passion for learning SHM topic, are necessary, namely GATA-FISIKA. GATA-FISIKA is a learning model and media using traditional game approach namely *engklek* integrated with digital technology in the form of Macromedia Flash for SHM topic. *Engklek* is a traditional playground game for children which can be played in a set numbers of players. The players toss a small object into numbered rectangles or triangles outlined on the ground prior to hopping or jumping with one foot through the spaces to regain the object. GATA-FISIKA was designed like a game having a game dynamic giving a reward for the best player. GATA-FISIKA was created to be able to improve the students' interest in learning since the taught students could learn while playing. Besides, GATA-FISIKA was designed to be able to enhance the students' mastery of concept by increasing the students' interest in learning and digital technology integrated with it.

2 METHOD

This research aimed to improve the students' understanding of simple harmonic motion concept. The research focus was to know the effectiveness of GATA-FISIKA in helping the students to understand the simple harmonic motion topic. This research used a Mixed Method research design with an Embedded Experimental Design developed by (Creswell, 2017). Hence, the obtained data were quantitative and qualitative. The research design used was One Group Pretest-Posttest, where the research stages can be seen in Figure 1.

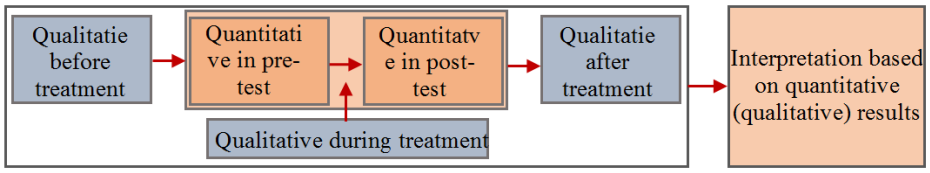


Figure 1: Mixed methods research design with embedded experimental design (Creswell, 2017).

The research subjects namely the students of X MIA 5 consisting of 28 students SMA Negeri 9 Malang. The research instruments were the questions of pre-test and post-test in the form of multiple-choice with reason, interview sheet, and questionnaire before and after learning using GATA-FISIKA. Before using the instrument, it was firstly validated and tested limitedly. The instrument validation was done to some experts namely two lecturers of physics. Based on the validation results, the topic in GATA-FISIKA was stated as very feasible with the mean of 87.5% and the media of GATA-FISIKA was stated very feasible with the mean of 93%. Meanwhile, the results of the validation of item instrument in the form of ten multiple-choice questions with reason tested to the students of SMAN 9 Malang that had taken SHM could be stated valid with the reliability of 0.704.

The data were taken using a test, interview, questionnaire distribution, taking a picture, and video documentation. After that, the quantitative data analysis technique used SPSS 16.0 and Ms. Excel 2013. The quantitative analysis was started with a descriptive statistic, pre-requirement test (normality), difference test with a paired test, n-gain and d-effect size. Furthermore, the qualitative data analysis was carried out by reduction, representation, data interpretation, and drawing a conclusion.

The improvement of the understanding of SHM topic using GATA-FISIKA could be obtained by analysing the students' scores of pre-test and post-test where before doing descriptive statistical analysis, the normality and difference tests were conducted. The descriptive statistical analysis results showed the score of mean, maximum and minimum scores, and the total number of the scores of pre-test and post-test that can be seen in Table 2. The results of the normality test can be seen in table 6, and the results of the difference test using a t-test can be seen in Table 3.

3 RESULTS AND DISCUSSION

Table 1: The result of descriptive statistic

	N	Minimum	Maximum	Mean		Std. Deviation	Skewness	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error
Pre-test	28	0.00	30.00	9.2857	1.53690	8.1350	0.581	0.441
Post-test	28	50.00	90.00	71.0714	2.01445	10.65947	-.029	0.441
Valid N (listwise)	28							

Table 2: The result of normality test using one sample kolmogorov smirnov test.

	Unstandardized Residual
N	28
Kolmogorov-Smimov Z	1.199
Asymp. Sig. 2-tailed (p)	0.113

Table 3: The result of difference test using paired sample test.

Pair 1 Pre-test-Post-test	-6250	1.323	0.250	-6.763	-5.737	-250.000	27	0.000
	Paired Differences					t	df	Sig. (2 tailed)
	Mean	Std. Deviation	Std. Error	95% Confidence Interval on the Differences				
				Lower	Upper			

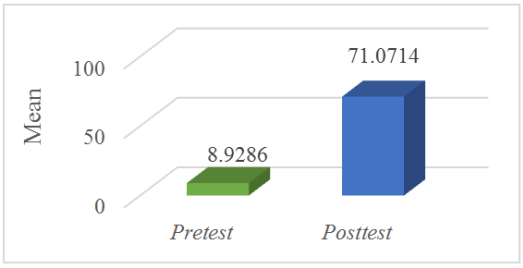


Figure 4: Graph of comparison of mean in pre-test and post-test.

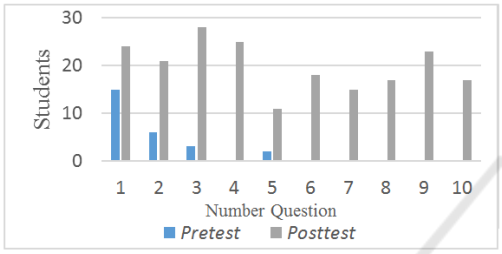


Figure 5: Graph of comparison of the number of students answering correctly in pre-test and post-test.

Table 4: Tabulation of the cross of number 3.

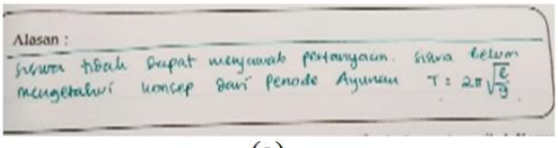
		Pre-test						Total
		A*	B	C	D	E	Empty	
Post-test	A*	3	5	1	0	0	19	28
	B	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0
	D	0	0	0	0	0	0	0
	E	0	0	0	0	0	0	0
	Empty	0	0	0	0	0	0	0
Total		3	5	1	0	0	19	0

Figure 4 shows that the means of pre-test and post-test were 8.93 and 71.07, respectively meaning that there was a significant improvement in SHM understanding. Besides, the qualitative analysis of learning using GATA-FISIKA indicated that the students felt more pleasure when learning using GATA-FISIKA since it is unique, interactive, arising discussion, and improving the students' critical thinking. In addition, during the learning, the students were not frantic and more courageous to express their opinion.

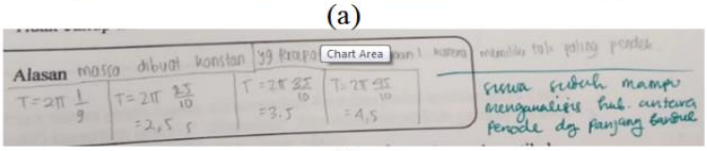
The mean of post-test was 71.07 meaning that the students were still difficult in understanding SHM. The students' difficulty could be explained through the analysis of students' answer. The following is the analysis of students' reason for the question with the lowest enhancement of the number of students answering correctly that was number 5.

In the item number 3, the students' understanding significantly increased proven by the students answering correctly increasing from three students to 28 students. The indicator of the item number 3 is analysing the pendulum period with the various rope lengths. The students were demanded to understand the period concept and what quantities that influence the period. Based on table 8, in pre-test, three students answered A, five students answered B, one student answered D, and the rest of them did not answer. Meanwhile, in post-test, 28 students answered A where A is the right answer. The students that had correctly answered A had been able to understand the concept of pendulum period where the longer the rope, the pendulum period will be longer in accordance with the equation 1. The students who answered except A had not understood the concept of period correctly. Figure 6 presents the example of the students' work on the item number 3.

$$T = 4\pi\sqrt{\frac{l}{g}} \qquad (1)$$



(a)



(b)

Figure 6: Description of student's reason for item number 3 (a) wrong reason (b) right.

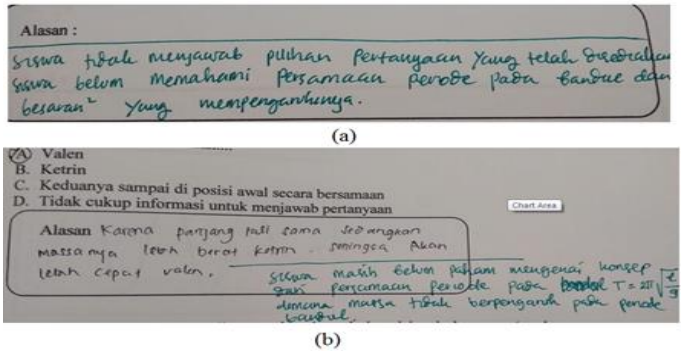


Figure 7: The description of student's wrong reason of item number 5 (a) in pre-test (b) in post-test.

For item number 5, the students' low understanding of SHM increased indicated by the students who correctly answered from two students became 11 students. The question number 5 is related to determining the period if the load mass is diverse. Both question number 3 and 5 discuss the pendulum period. However, for item number 5, many students had not understood that mass does not influence the pendulum period. Based on Table 9, in the pre-test, six students answered A, nine students answered B, 12 students answered C, and one student did not answer. The choice of C is the right answer. The students who answered C had understood that mass does not influence the pendulum period. Meanwhile, the students who answered a thought that the heavier the mass, the pendulum period is faster. The students thought that mass influences the pendulum motion to the vertical direction, whereas it does not. The students who answered B thought that the light mass could accelerate the pendulum period; this reason is wrong as well.

Table 5: Tabulation of cross of number.

		Pre-Test						Total
		A	B	C*	D	E	Empty	
Post-Test	A	1	0	1	0	0	4	6
	B	0	0	0	0	0	9	9
	C*	5	0	1	0	0	6	12
	D	0	0	0	0	0	0	0
	E	0	0	0	0	0	0	0
	Empty	0	0	0	0	0	1	1
Total		6	0	2	0	0	20	28

Moreover, the analysis of students' difficulty for ten items explained in the sub-chapter of the topic is in accordance with Table 6. Based on Table 6, the sub-chapters of SHM topic that were hard to understand by students were velocity, force, and energy of spring and pendulum as well as the graph of SHM equation, where the percentage of the students who understood was only 50%

Table 6: The Understanding of SHM-Sub-Topic.

Sub-Topic	Understand (%)	
	Pre-Test	Post-Test
	57.1	85.7
Pendulum period	9.8	75.9
Graph of SHM Equation	0	59.5
Velocity of spring and pendulum	0	67.9
Force of spring and pendulum	0	53.6
Eenergy of spring and pendulum	0	60.7

Based on the analysis results, this research is in line with the other research conducted by (Sakti, 2013), where the learning using direct instruction model through animation media of Macromedia Flash could improve the students' passion and understanding. Besides, the use of the traditional game of *engklek* added the interaction between students arisen from the discussion process. The students' difficulty in understanding SHM also occurred in this research as well as the other research (Aprilia, Syuhendri and Andriani, 2015; Husniyah, Yuliati and Mufti, 2016; Haryono, 2017). This case showed that there were the other factors which caused such misconception. One of the causes was the students often asked for permission to leave the learning due to another activity (Observation in SMAN 9 Malang, 2018).

4 CONCLUSION

SHM learning using GATA-FISIKA could be significantly influential based on the score of the effect size of 5.133 and improve SHM understanding

based on the score of n-gain of 0.601. The qualitative data before learning using GATA-FISIKA were obtained from the results of the interview with the physics students in SMAN 9 Malang showing that physics learning was monotonous where the teacher was lack of various ways in learning, and less able to make the students understand. Meanwhile, the qualitative data after learning using GATA-FISIKA indicated that the learning using GATA-FISIKA made the learning pleasant, unique, not frantic, and arising discussion and increasing the students' thinking skills.

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