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Teaching oscillations and waves during the COVID-19 pandemic using the flipped classroom

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ABSTRAK

The COVID-19 pandemic has posed a major challenge to education systems around the world. Schools and universities were encouraged to eliminate or limit face-to-face learning activities to prevent the spread of COVID-19. In this present study, the flipped classroom model has been proposed as a solution to this challenge. The purpose of this research was to investigate the effect of the flipped classroom model on students' cognitive learning outcomes in learning oscillations and waves. The learning achievement was measured by the Oscillations and Wave Achievement Test (OWAT) consisting of 15 items. This pre-experimental with a one-group pretest-posttest design was conducted at a small public school in Tanjung Jabung Barat, Jambi. A total of 27 junior high school students participated in this present research. The results of average normalized gain showed that the use of the flipped classroom model had a positive effect on students' cognitive learning outcomes in learning oscillations and waves.

Keywords : *COVID-19 pandemic, flipped classroom, physics learning*

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INTRODUCTION

COVID-19 is still a global problem. All areas of life, including education, have been impacted by Covid-19. This condition has caused many countries in the world to take policies that can break the chain of the spread of COVID-19. The action that must be taken, of course, is to limit all activities that take place face-to-face. As in other fields, the outbreak of COVID-19 poses a major challenge to education (Sepúlveda-escobar & Morrison, 2020). The world is forced to innovate in carrying out learning activities so that the quality of education does not

decline during the COVID-19 pandemic. In response to this, the Indonesian government decided to close schools and universities. This decision was followed by an appeal to all school and university leaders to carry out online learning.

However, this policy was a big challenge for several schools or universities (Sakti & Sukardi, 2021). Indeed, online learning is not something new (Adedoyin & Soykan, 2020), but there are many schools in Indonesia that do not have adequate equipment to carry out online learning such as computers or laptops. Furthermore, many students cannot access the internet because they are in remote areas. This condition is faced by the author as a teacher at a public school in Jambi province, West Tanjung Jabung district. In other words, online learning cannot be used as a solution, not even as an option for teachers to teach students in this school during COVID-19. This situation was almost the same as what happened in Pakistan. Adopting online learning in the midst of limited facilities and internet access caused learning outcomes not as expected and even online learning was not as effective as traditional learning (Adnan & Anwar, 2020).

In addition to online learning, flipped classroom is also in the spotlight during the covid-19 pandemic, even though flipped classrooms were popular before the outbreak of covid-19. Flipped classroom is a learning model that consists of pre-class and in-class learning activities with the help of technology (Aşıksoy, 2017). Learning outside the classroom can be done by students to study subject matter assisted by technology such as learning videos or learning management systems (LMS) as a knowledge transfer phase while learning in class can be done by students to do assignments or practicums by involving teachers or peers as a knowledge construction phase (Bergmann & Sams, 2012; Wang et al., 2018). Flipped classroom is identical to the concept that students must learn independently by using learning videos or other learning resources provided by the teacher before participating in learning activities in class (Bergmann & Sams, 2012). Thus, during in-class activities, students have more time that can be used on problem-solving, discussion, and laboratory practicum (Zainuddin & Halili, 2016). The students have the flexibility of time in learning because they utilize technology that can be accessed outside the classroom (Aşıksoy, 2017). Therefore, the flipped classroom model can increase the interaction between educators and students (Aşıksoy, 2017). so that student learning outcomes also increase (Yen, 2020). Learning activities outside the classroom in the flipped classroom such as using learning videos, online quizzes, learning management systems make the flipped classroom known as a learning approach that cannot be separated from the use of technology. Nevertheless, a teacher does not have to be an expert in making learning videos to be able to apply flipped classroom in their class because learning videos can be obtained from various sources, such as Youtube and Khan Academy (Ozdamli & Asiksoy, 2016).

Previous flipped classroom research showed that flipped classrooms could improve student learning outcomes (Bhagat et al., 2016; Peterson, 2016). Nonetheless, these studies were conducted before the Covid-19 pandemic. During the Covid-19 pandemic, the flipped classroom was innovated into a flipped classroom with online-based teaching. In-class activities that were previously carried out face-to-face in the classroom were changed to virtual classroom activities such as using Google Meet and Zoom. Many recent studies conveyed that flipped classroom with online-based teaching can be used as a learning strategy under COVID-19 (Anugrah et al., 2020; Campillo-Ferrer & Miralles-Martínez, 2021;

Hasanah et al., 2021; Reflianto et al., 2021; Ringo, 2021; Tang et al., 2020). However, this flipped classroom with online-based teaching cannot be implemented if students have difficulty accessing the internet. Therefore, in the midst of the popularity of online learning and flipped classrooms with online-based teaching under Covid-19, the authors chose the traditional flipped classroom to be used in carrying out teaching activities. The traditional flipped classroom model refers to a form of flipped classroom that involves face-to-face learning activities in the classroom (not virtual) (Bergmann & Sams, 2012; Ozdamli & Asiksoy, 2016).

One of the physics materials taught in junior high schools is oscillations and waves. Several studies revealed that there are some misconceptions that often occur when students study oscillations and waves (Kennedy & De Bruyn, 2011; Tongnopparat et al., 2014).. During the Covid-19 pandemic, low understanding and misconceptions often occur due to the lack of communication that occurs between students and teachers in teaching activities (Puspitasari et al., 2021). This often happens in online learning where the teacher is the main character who explains the material and students only listen, take notes, and do the questions. The traditional flipped classroom probably could accommodate this problem because learning activities in the classroom are carried out face-to-face and have more time which allows for intense interaction between students and teachers. Moreover, the flipped classroom approach is appropriate for teaching physics because in the classroom students can focus more on studying and discussing the study material that is not yet understood, practicing problem-solving, and doing a practicum. Studies on physics learning showed the flipped classroom approach can improve knowledge and learning motivation (Aşıksoy, 2017; Atwa et al., 2016; Ozdamli & Asiksoy, 2016). Therefore, this study aimed to investigate the effect of the application of the flipped classroom on students' learning outcomes in learning oscillations and waves during the COVID-19 pandemic.

RESEARCH METHODS

This pre-experimental study used a one-group pretest-posttest design. It took place in SMPN Satu Atap 1 Pengabuan, a public junior high school in Jambi, Indonesia. This study focused on the learning outcomes of 8th graders on the oscillations and waves so that the population in this study was all 8th graders in SMPN Satu Atap 1 Pengabuan. Since the number of 8th graders was small, we decided to include all 8th graders as the research sample ($N = 27$). Thus, this study employed total population sampling where the entire population was included in the study as a sample. The students, 15 females and 12 males ranged in age from 14 to 15 years. None of these students had previous experience with the flipped classroom. During the COVID-19 pandemic, this school is still open due to limited internet networks that do not support the implementation of online learning. To prevent the spread of COVID-19, students come to school two days a week and have to wear masks.

In this present study, carried out over four weeks in April 2021, students learned oscillations and waves through the flipped classroom model. Students were asked to prepare for class at home by watching instructional videos. The teacher made these videos specifically for students to learn oscillations and waves. The duration of each video was under 10 minutes so that students would not feel bored watching the videos because of the long duration. Due to

poor internet connections, the teacher chose to send videos to students' smartphones using Bluetooth instead of uploading videos on YouTube or WhatsApp groups. Through these home activities, students are expected to be able to achieve the basic domain of Revised Bloom's Taxonomy (Nouri, 2016; Sohrabi & Iraj, 2016). Furthermore, students were encouraged to prepare questions about pre-class material that they did not understand.

During the first ten minutes, the teacher and students discussed the topic on videos in class. Furthermore, students conducted experiments in some small groups using the offline version of the PhET simulation (Figure 1). After experimenting, students discussed the results in their groups and answered some questions on the worksheets. The following is a sample of student tests and worksheets:

https://www.mediafire.com/file/7tf2kc4gi57o71q/Sample_Ringo_Gravity.zip/file

Finally, students presented their work and acquired the feedback from other students and the teacher.

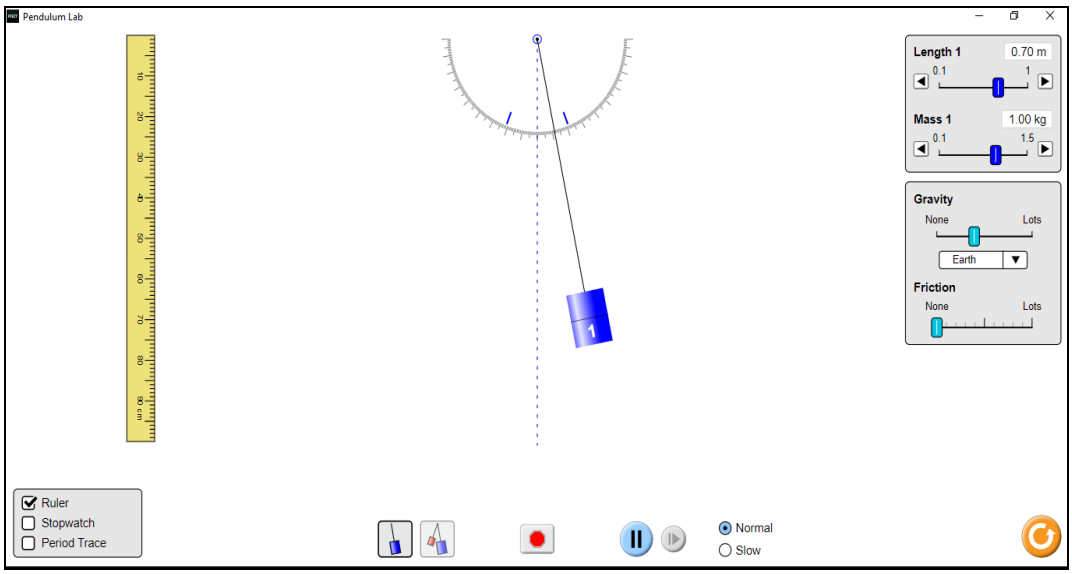

Figure 1. PhET simulation

Before and after the intervention, students took the pretest and posttest which have the same contents. The instrument used has been validated and tested. The validity test was carried out by two lecturers and one teacher and reliability test was conducted by involving 25 students. The results indicate that the instrument is valid and has high reliability (0,81). Figure 2 shows the example of the test.

The basic difference between transverse waves and longitudinal waves is...
a. frequency
b. amplitude
c. the direction of propagation
d. wavelength

Figure 2. The example of the achievement test

The collected data were used to investigate the improvement of students' cognitive learning outcomes by using the N-Gain (Hake, 1998, 2002) as shown below:

$$<g> = \frac{\langle posttest \rangle - \langle pretest \rangle}{100 - \langle pretest \rangle} \qquad (1)$$

Where <g> is the course average normalized gain, ⟨pretest⟩ is pretest class average and ⟨posttest⟩ is posttest class average. The result of <g> is interpreted as shown in Table 1.

Table 1. Average normalized gain interpretation

Average normalized gain	Criteria
$(\langle g \rangle) \geq 0.7$	High
$0.7 > (\langle g \rangle) \geq 0.3$	Medium
$(\langle g \rangle) < 0.3$	Low

(Hake, 1998)

RESULTS AND DISCUSSION

This study aimed to investigate the effect of the application of the flipped classroom on students' cognitive learning outcomes in learning oscillations and waves learning during the COVID-19 pandemic. The results of the pretest and posttest carried out are shown in Table 2.

Table 2. Pretest and posttest results

Pretest average	Posttest average	Average normalized gain
4.63	71.89	0.71

Based on Table 2, it can be interpreted that students' cognitive learning outcomes highly increased after learning oscillations and waves taught by employing the flipped classroom model. The average normalized gain, 0.71, clearly proves that the flipped classroom can be one of the learning models used by teachers in teaching the oscillations and waves during the Covid-19 pandemic where schools were required to reduce face-to-face learning. This finding is consistent with the results reported from other studies conducted during the Covid-19 pandemic (Alamri, 2019; Dewi et al., 2021; Marina & Ridlo, 2021).

The improvement of students' cognitive learning outcomes could not be separated from the influence of students' preparation in participating in learning activities. The teacher provided videos that had been specially designed for students to study at home. Students who have watched and studied the videos were more likely able to take part in experimental activities in class and more likely to succeed on the post test. On the other hand, students who ignored watching videos would more likely have difficulty participating in learning activities in class. This effect might be explained by reviewing the learning objectives of pre-class and

in-class learning activities based on Revised Bloom's Taxonomy. Home learning activities are focused on achieving the learning objectives included in the lower level of Revised Bloom's Taxonomy, such as remember and understand while face-to-face instructions are aimed at achieving learning objectives, such as analyze and evaluate (Gilboy et al., 2015). Students who did not carry out pre-class activities will come to class without the basic knowledge needed to conduct experiments. For example, in-class activities, students were assigned to measure the period of a simple pendulum through a virtual experiment by using PhET. To be able to do this task, students must first understand the concept of oscillation and they should learn this concept through home learning activities.

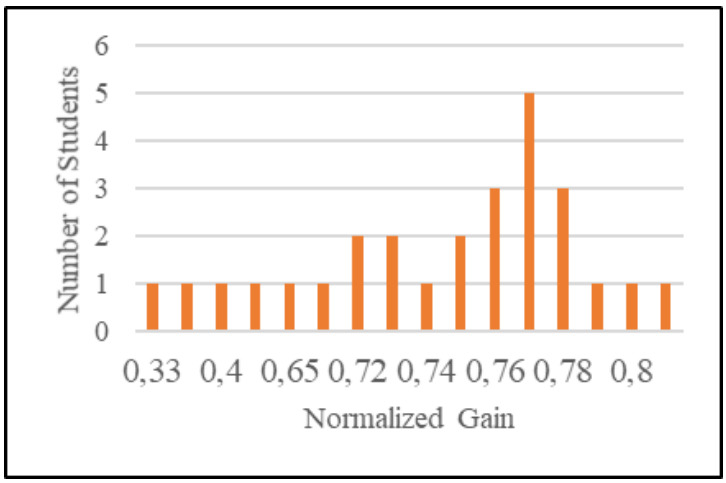

Figure 3. Number of students versus normalized gain

Figure 3 indicates that some students obtained a normalized gain value below 0.7 which is categorized as medium and the lowest normalized gain value was 0.33. Even though this value is not included in the low category, this student obtained a score below the standard score that had to be achieved by students. Several factors could possibly cause this. To begin, learning by using flipped classroom was new for students. In traditional classrooms, students are not required to come to class with some preparations, while in the flipped classroom, students are required to study at home before attending class, such as watching videos, reading books, and taking quizzes. Not all students can immediately adapt to this change so that it has a negative impact on students' readiness to take part in face-to-face learning activities in class (Schiller & Herreid, 2013). In addition, the learning activities have shifted from teacher instruction to student-centered learning (Abeysekera & Dawson, 2015). Instead of just listening to the teacher's lecture, students can be involved in active learning, such as pair and share activities, individual or paired quiz, and presentations and discussion (Mclaughlin et al., 2014). Last, some students seemed confused in following the learning activities using the PhET simulations. This might potentially happen because they had no previous experience in using computers or laptops. In this condition, the teacher guided students patiently in carrying out experiments using PhET simulations and answering questions on the worksheets. The teacher also motivated students to be actively involved in the experiment.

CONCLUSION

Teaching using the flipped classroom model can be considered to improve students' cognitive learning outcomes of oscillations and waves during the COVID-19 pandemic. However, its implementation requires more extra preparation than traditional learning activities. Teachers need to design and create videos for students to study at home and guide students in learning activities in class. The result of this study confirms one of the advantages of the flipped classroom model. Nevertheless, some limitations in this research should be noted. This study employed a small sample size (only one class) to investigate the effect of the flipped classroom model so that this study cannot compare the effect of applying the flipped classroom model with the traditional classroom approach. Moreover, students did not have experiences with the flipped classroom model and the research duration was not long enough. The positive impact of the flipped classroom may only be a form of enthusiasm at the beginning when encountering something new. Future research should be able to address the limitations. In addition, future studies can investigate more deeply how often students watch a given video and the effect on student learning outcomes.

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