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Research Article

Pop-up question on educational physics video: Effect on the learning performance of students

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Abstract: Pop-up question video has been developed in oscillation physics concept to support the student's learning objection in a Junior High School level. This video use as learning source to support the information gaining in particular use of learning design. This study aimed to analyzes the effect of physics pop-up question video relating to oscillation to the student's learning performance. Furthermore, this video developed based on the recommendation of previous research to decrease the students' cognitive load. Besides, this particular research aimed to measure the students' learning performance on 100 students in junior high school level. Learning performance consists of the concept attainment of oscillation concept, students' motivation and students' cognitive load atter pass the learning process with pop-up question video. As results, the students' concept attainment in a percentage of 74% and stated in a good category. Then, the students' motivation has the percentage of 84% and state in a good category while the cognitive load percentage on 38% and stated in a less category. It means, the pop-up question video has good impact on students' motivation and has a less cognitive load simultaneously. However, for gaining the better result, pop-up question video can be integrating to the innovative learning model.

Keywords: cognitive load; pop-up question video; students' motivation

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1. Introduction

Learning source is an important aspect while gaining physics concept understanding in a learning process. In everyday life, physics can be found easily around and numerous in every student. As this condition, they should gain more information while connecting the real-life fact or identify the physics concept. A good physics understanding concept is achieved when the everyday experience and the relating physics concept are merged (Bao & Koenig, 2019; Lodge et al., 2018). One of the common physics phenomena easy to find is vibration or oscillation concept. Oscillation is the repetitive motion, typically in time while move from different states across the equilibrium (Garrett, 2020). This concept important to understand due to the basic knowledge to learn more concept in wave. Furthermore, the basic information on oscillation consists of the vibration on pendulum and spring, frequency, period, and the relation between frequency and period.

Using a combination of visual and audio in an instructional process as a learning source is nothing new (Puspitarini & Hanif, 2019; Shabiralyani et al., 2015). A teacher likely understands the potency of this learning material to succeed the educational purpose. This can be observed easily a video is the substitute media when some particular objects or process can't be observed easily, difficult to find, or expensive materials. In learning process, a specific video commonly mentioned as educational video-commonly used as the information source at home in flipped classroom design (Bishop & Verleger, 2013). In this learning setting, the traditional activity in classroom shifted and "flipped" to the outside activity (Li et al., 2018; Limniou et al., 2018). For fulfil this purpose, the traditional method succeeds with educational video. Afterwards, the using of educational video in flipped classroom shown the improvement in students' performance toward Science, Technology, Engineering and Mathematics (STEM) on high school level (Baepler et al., 2014; Lax et al., 2017). Not only at the STEM performance, the use of educational video in any surveys shown the similar result (Lin et al., 2017; Paul & Jefferson, 2019; Roberts et al., 2018; Yang, 2017). The educational video reinforces the learning material, develops the common base of knowledge, triggered the students' discussion, increase the students' enthusiast and motivation, and accommodate the different learning style. Educational video content

Although the using of educational video increase the several students' performance, many challenges are meet in the application of this media. Two major challenges are the teacher difficulty in content on video development and find the suitable concept for educational video. Besides, the other challenges come from the students' readiness in class after the learning from video at home (Herreid & Schiller, 2013; Mishra et al., 2020; Zalat et al., 2021). The second problem is the fundamental condition, as the concept of flipped classroom students must master the main concept or information before class. Their condition will affect to the class activity in classroom and affect to the learning purpose achievement. It means, need certain video to make sure that students get the information from the video.

In education, to make sure that each student 'study' and get new information can be hold in assessment process. In the perspective of cognitive theory, the video design supports the cognitive process of relating concept without overloading the cognitive capacity. For avoid the cognitive load, it promotes with segmentation and signaling (Ibrahim, 2011; Zheng et al., 2022). In this video design, segmentation defined as the division while developing the video. In this particular design, the oscillation segmented into 5 parts: vibration in pendulum, vibration in spring, frequency concept, period concept, and the relation between period and frequency. In signaling, the visual and audio signs use to increase the focus on each segment. As the content in this video, only the information explain are shown in video on a frame.

For combining the assessment process for make sure students have the information in educational video, the highly recommendation for the challenges are pop-up question within the video (Cummins et al., 2016; Lavigne & Risko, 2018; Szpunar et al., 2014, 2013). These questions can be shown in a multiple choice or the brief description. In this study, the question writes in isomorphic. Isomorphic question requires the question in pair and need the same physics concept to solve the problem (Diyanahesa et al., 2017; Millar & Manoharan, 2021).

The using of interpolating test after use the pop-up question video show the positive effect, show the improvement in retention of information (Pastötter & Bäuml, 2014). Moreover, students more focus after each segment on this kind of video and question is a segmentation tool (Szpunar et al., 2013). It means, previous studies on pop-up question video might increase the learning quality both directly and indirectly by helping student to focus on a particular information due to the question. This question help student to make more attention on the concept of the question. However, the more insight of the pop-up question video using, especially in physics help teachers to design the effective video. Particular learning process commonly triggered the students' motivation level. It is important to analyze the students' motivation to improve students learning performance (Hwang et al., 2013). On the other hand, the use of particular media, pop-up question video might be even decreasing the motivation level and cause the negative effect. That is, to improve the learning performance should have good concept achievement, high motivation, and minimum cognitive load. Consequently, this study aimed to analyzes the effect of physics pop-up question video relating to oscillation to the student's learning performance.

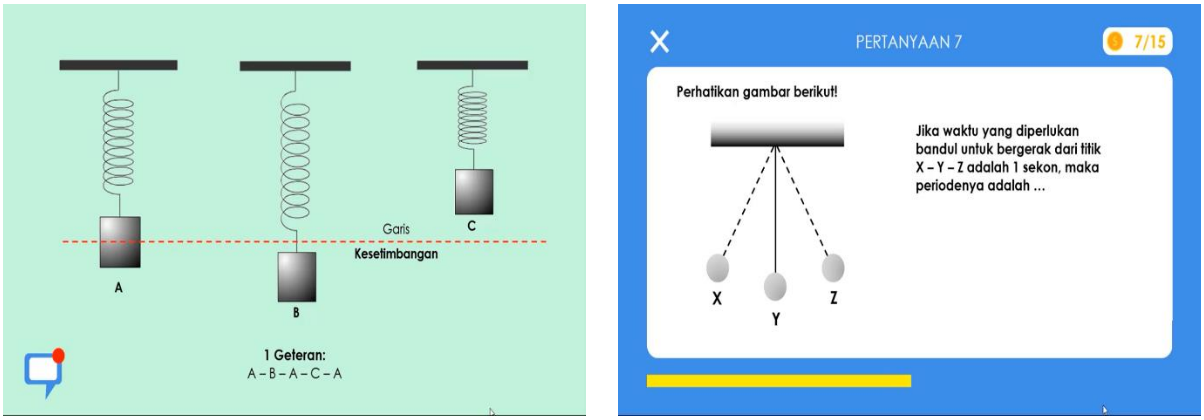
2. Materials and Methods

2.1 Participants

The participants of this subject are the 100 students in a junior high level in Indonesia. All the participants are a whole student on 8th grade level relating to the sample formulation. Note that all the participants are male, due to the boarding concept and avoid the gender influence on this research. The assessment of the learning performance done during and after the learning process with pop-up question video.

2.2 Pop-up design

In this development pop-up question video, the physics question writes in three questions in every segment. This kind of question chosen to make sure that students understand the question-avoid the luck factor while answer the question in a brief description. The sample of visual appearance of the developed pop-up question video shown in Figure 1.



(a) (b)

Figure 1. Pop-Up Question Video interface view: (a) explanation of oscillation on spring, (b) one of the three isomorphic questions relating to period.

2.3 Course design

This particular research uses quantitative descriptive and a part of quantitative method (Riduwan, 2018). As the profile of students learning performance consist of the three aspects. Hwang et al (2013) mention the learning performance as students' motivation level, cognitive load level, and technology acceptance. However, the learning with pop-up question video is a kind of video, commonly uses for students at this school. Furthermore, the concept attainment needs to analyze as the importance of information gathering in video-based instruction. Students watch the video twice and have to answer the 15 question which segmented into five aspects: oscillation on pendulum, oscillation on spring, frequency, period, and frequency-period relation. This segmentation is a method to decrease the cognitive load and gain more attention of smaller portion in every physics concept. Noted that the question writes in isomorphic to measure the more accurate students understanding.

The subjective cognitive load measurement and motivation level gain by the instrument developed from previous research and write in Likert scale (Hwang et al., 2013). These instruments give to students after watch the video twice. For gaining more information, teacher observe the students' condition during the treatment. Moreover, the students' score attainment, motivation instrument data and cognitive load instrument data categorized according to the Table 1 (Riduwan, 2018).

Table 1. Interpretation of percentage data.

Percentage (%)	Category
0- 20	Very less
21 - 40	Less
41 - 60	Middle
61 - 80	Good
81 - 100	Very good

3. Results

As the parts mentioned before, the students' performance describes the three results as students' concept achievement on pop-up question, students' motivation, and students' cognitive load. Every result complete with the discussion relating to the finding fact of every part.

3.1 Students' concept achievement

This research developed and use the pop-up question video in direct learning setting. The video developed based on the national curriculum of junior high school level. This video has a duration of 20 minutes and contain the preconception, explanation, and isomorphic question. The first part of the video begins with the application of oscillation in a real life, by showing the earthquake vibration. After that, the explanation of oscillation on pendulum and spring, frequency, period, and the relation between the frequency and period. The isomorphic questions appear on last parts of every segment, hold 20-30 second after the narration. This research uses the three questions on every segment, when student can answer three questions correctly,

On this learning activity, the effect of watching this video can observe with the students' answer on the pop-up question. As the precondition, the students haven't this concept in school before, so many terms contain on this video particularly new on the students' mind. The students' answer on the right answer percentage show at the Figure 2.

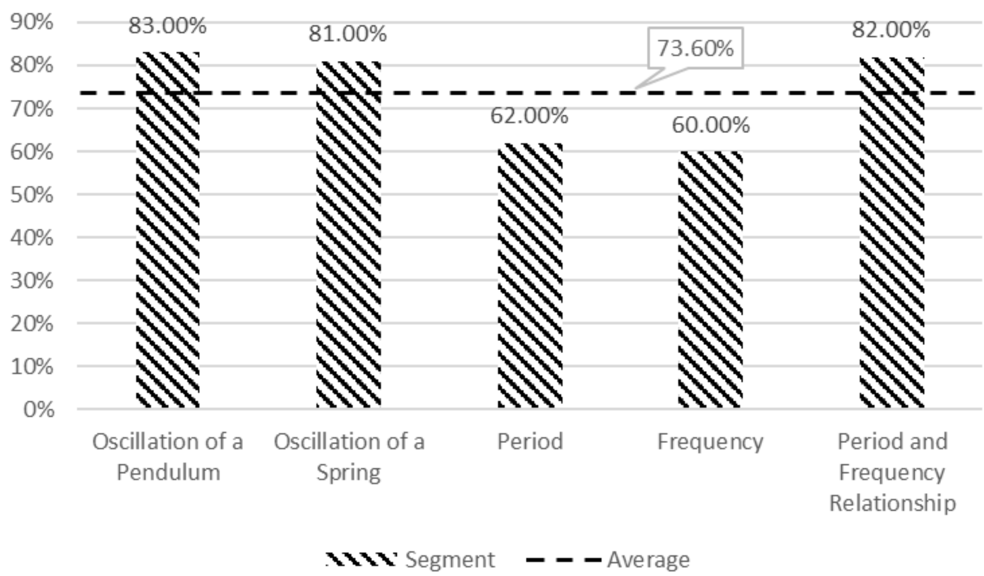


Figure 2. The percentage of the students' correct answer in every segment.

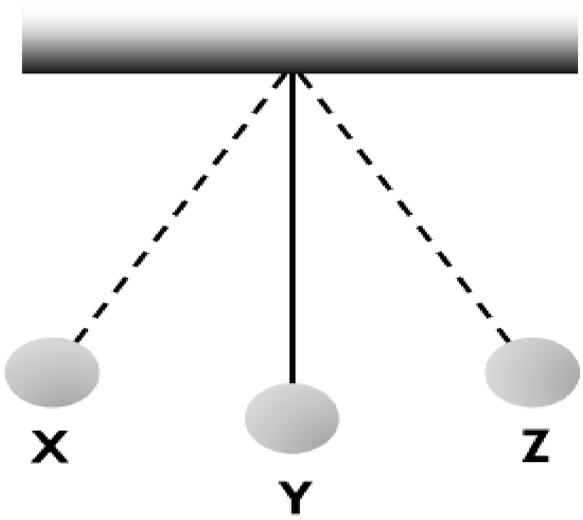


Figure 3. Three positions of pendulum while oscillating.

Different from the two first segments, the two next segments have the high difference (20%). As mentioned in previous part, the different characteristic between the oscillation on pendulum-spring and frequency-period state on the complexity of every concept. In oscillation, students have to determine the full cycle, through in frequency and period have to determine the value of frequency and period based on the time interval of two different position. As example in pendulum on Figure 3, "if the time takes for the pendulum to move from X-Y is 0,5 second, then the frequency is ... ". For determine the correct answer on this question, students must remember on the definition of frequency. The frequency represents the number of oscillations undergoes per second. Hence, the answer is 0,5 Hz.

Although the frequency and period segment have a lower percentage, the segment of relation between frequency and period have the different result. The different representation is an aspect of this reason. This last segment uses the mathematical representation for determine the relation between frequency and period. Furthermore, the simple mathematics process indicates of this result, student just insert the known value to the explained formula. In order to smaller the difference between segments, there is some suggestion need in the pop-up question video. It is the extra instruction of video using. Students should write the important information on this video. They can pause the video and write it, so they can answer every question easier and decrease the cognitive load.

3.2 Students' motivation

After the learning activity, the students took the learning motivation questioner. The description of the motivation aspect and the students answer show in Figure 4. Based on the results, this aspect variate in percentage of 76,5% to 90,5% with the average of 83,88%. If compared to the Table 1, this result has a very good category. This result is reasonable since the use of pop-up question video is new on students and as the characteristic of students like something new in their learning process. In details, the data of this aspect supported by the observation in class. As the lowest percentage in motivation, a student answer that he will not actively look for information and learn about natural science because his perspective on natural science is difficult. Moreover, he difficult to answer the question in video.

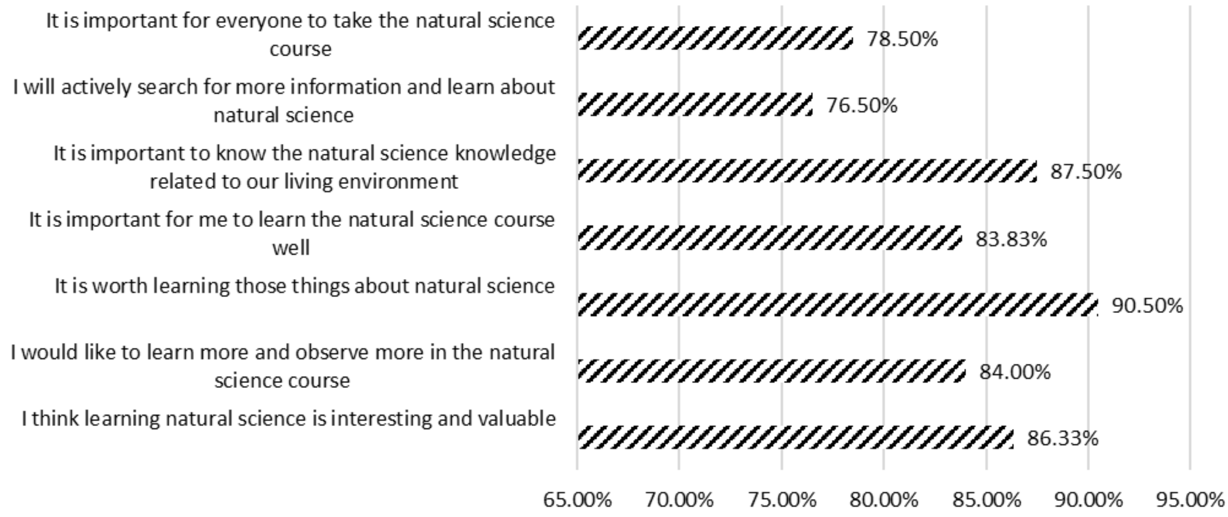


Figure 4. The percentage of the students' motivation.

3.3 Students' cognitive load

The students took the cognitive load questioner after finish the learning activity with pop-up question video. The description on every question shows in Figure 5. Based on the results, this aspect variate in percentage of 32,83% to 43,5% with the average of 38,06%. If compared to the table 1, this result has a less category. It means, the cognitive load has a less category after they study in pop-up question video.

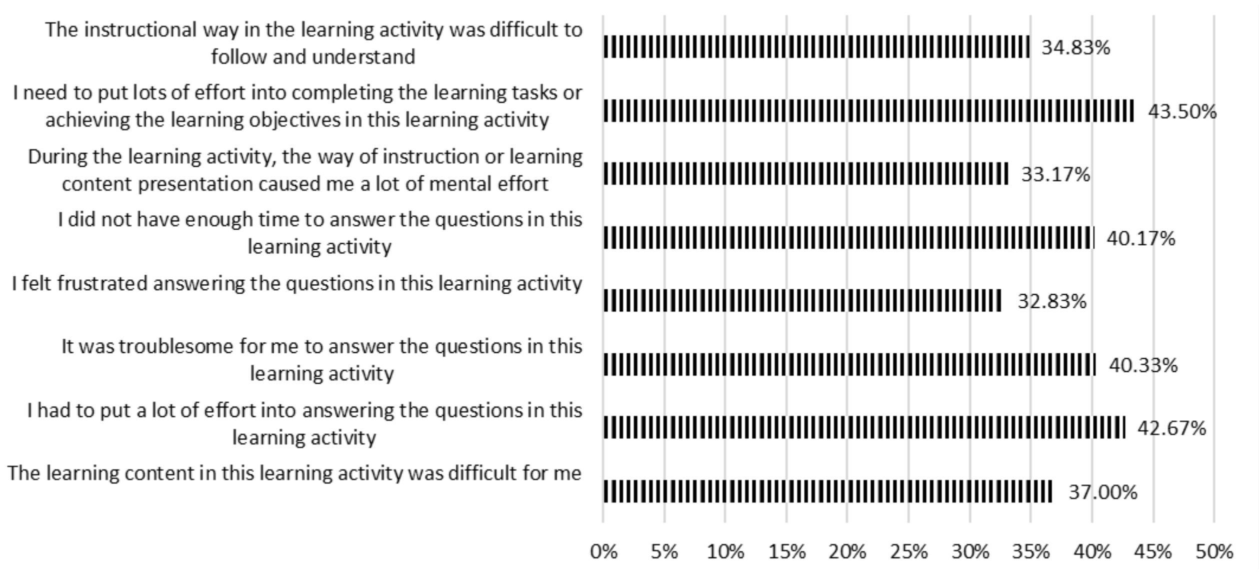


Figure 5. The percentage of the students' cognitive load.

4. Discussion

4.1 Students' concept achievement

Based on the result, the percentage of the students' achievement in a range of 83% to 60% with average of 73,6%. In a whole percentage, majority of student can answer the five segments question and if compared to the table 1 has the category of Good. This result relating to the previous research which have the good impact after pass the learning activity using pop-up question video (Haagsman et al., 2020; Vural, 2013). However, the difference of the highest and the lowest segment reach 21% students. It means, every segment has the different characteristic. In the highest percentage, oscillation in pendulum succeed to be understand by the majority of students. This segment shows the question with an illustration as show at the Figure 3. Three different positions of a pendulum pointed as X, Y, and Z. Students have to determine the position of pendulum in one full cycle of oscillation if it start from a certain position. The other 17% students answer the wrong answer on this segment. All their mistake come from the wrong determination of 1 cycle oscillation. They think that 1 cycle hasn't to come back to the begin position. As commonly known in physics, 1 full cycle of oscillation if begin from X is X-Y-Z-Y-X instead of the all-students wrong answer X-Y-Z-Y. In second segment (oscillation of a spring), not all students with a correct answer on first segment can answer the question of this segment correctly. 2% students have difficulties on determine the one full cycle of oscillation in a spring.

4.2 Students' motivation

As the solution of this problem, the improvement of the personal use of pop-up question video can be achieve on specific setting. As the previous research, student can't continue to the next segment if he writes the wrong answer (Haagsman et al., 2020). Different from this research, the concept attainment measures the students understanding just after watch the explanation-analyze the explanation effectivity on video. This will make sure students understand every concept in video. So, it can be motivating students while learning physics on natural science.

4.3 Students' cognitive load

This result likely to less cognitive load occurs due to the developing process of the video, use the recommendation based on the previous research. For minimize the cognitive load of educational video, it developed by using signaling to highlight the main information relating to the concept, use segmentation for decrease the information has to remember, eliminate the unimportant information or symbol, and use the complimentary visual and audio to convey complementary information.

However, the cognitive load measurement has typical characteristic. This research uses the indirect subjective measurement (Kalyuga & Plass, 2019; Reid et al., 2020; Schmutz et al., 2009; Zu et al., 2021). This method is common and use the questioner in which students are ask to report the level of mental effort they have while understanding the video. Although it can't describe the relation between the mental load to the actual cognitive load (de Jong, 2010; Minkley et al., 2021; Scheiter et al., 2020; Schnaubert & Schneider, 2022), the use of this questioner can be the first and easy method to indicate the cognitive load instead of the other method. Furthermore, other research state that since mental load refers to the interaction between task and subject characteristic, that interaction determine the students' knowledge (de Jong, 2010). In other hand, mental effort represents the cognitive capacity to accommodate the task and its demand. That is, mental effort uses in this research show the cognitive load aspect relating to the structuring and presenting the learning strategy use-pop-up question video integrate to the learning (Albus et al., 2021; Seufert, 2018).

Therefore, the satisfaction of results has caused by a new approach on learning media, especially on students' motivation. The use of educational video of the participants is nothing new-teacher show the relating video to the concept in his explanation. The new approaches come from the use of pop-up question in video as the direct assessment process after class. This finding provides the good reference of the pop-up question video using in effect of the students' performance for the next research.

On the other hand, there are some boundaries to the pop-up question video using. First, the supporting ability of pop-up question video on another model should analyzing further. Although the use of this media has been integrated to the flip classroom, it doesn't rule out the possibility to integrating pop-up question video on blended and hybrid design as the solution of online learning on pandemic era. Second, teacher should be clearly the concept segmentation due to decrease the cognitive load. Third, the development of the pop-up question video could be time consuming. To deal with this problem, we have a planning to develop the other pop-up question video for every concept of physics subject in junior high school level. Therefore, it is important to integrate this media in real time answer collecting program for gaining the students' respond effectively.

5. Conclusions

The effect of pop-up question on educational physics video on the students' learning performance described from the students' concept attainment, students' motivation, and students' cognitive load. The average percentage of the concept attainment after pass the learning process with pop-up question video is 74%. It means, 74% students get a concept understanding with succeed to answer the 5 segments of oscillation writes in brief description on isomorphic model. Furthermore, the students' motivation has the percentage of 84% and state in a good category while the cognitive load percentage on 38% and stated in a less category. However, for gaining the better result, pop-up question video can be integrating to the innovative learning model, both describe the students increase on students' concept attainment and motivation, and decrease the students' cognitive load.

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