Can a Collaborative Questioning Strategy with Web-based Formative Feedback Improve Understanding of the Simple Harmonious Motion Concept?

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Abstract: Simple harmonic motion is one of the fundamental concepts in physics. Nevertheless, some studies have found that many students have difficulty in learning this concept. This study aims to analyse understanding of the concept of simple harmonic motion of high school students who have studied with collaborative questioning with web-based formative feedback. The research used mix methods with embedded experimental design. The study involved 34 high school students consisting of 7 male students and 27 female students. The main instruments of the study included 9 graded validated multiple-choice test items with an Alfa Cronbach value of 0.87. N-gain and effect size analyses are performed on the test result data, while qualitative analysis is performed on the student's answer. The results showed that the average value of N-gain of 0.65 (height) and effect size 4.52 which is in the category is very large. This shows that the application of collaborative questioning along with web-based formative feedback can improve students' conception comprehension significantly.

1 INTRODUCTION

One of the focuses of physics learning is to deliver students to achieve good understanding of the concepts. Understanding of concepts and principles of physics is useful for explaining natural events (Brookes and Etkina, 2015) and helping students define concepts (Docktor and Mestre, 2014). Understanding of good concepts in students can be achieved through the provision of direct experience centered on students (Goodhew and Robertson, 2017). Students who master the concept are able to solve problems (Weaver et al., 2017) (Weaver *et al*., 2018). Based on this, understanding of the concept has an important role in physics.

Simple harmonic motion is a complex concept of physics. Simple harmonic motion learns about the movement of disturbed objects from equilibrium positions, macroscopic phenomena (DiSessa and Sherin, 1998). The characteristics of the pendulum motion cannot be explained or observed only from observation of the periodic motion phenomenon of the pendulum only. Therefore, many students still have not mastered the concept of simple harmonic motion (Adolphus, Alamina and Aderonmu, 2013). This is evidenced by the still low understand of concepts on simple harmonic motion concepts (Parnafes, 2010).

Some studies have found that there are still many students who have difficulty in studying simple harmonic motion. Students find it difficult to find the speed of oscillating objects that assume a constant value (Parnafes, 2010). Another difficulty is to determine the magnitudes affecting the spring period. Based on the results of a study of 100 students, more than 20% of students explained that the spring period depends on amplitude. Students reveal that the longer the track, the time it takes to get back to its original position will be longer (Frank, Kanim and Gomez, 2008). In addition, students have difficulty in solving problems mathematically and cannot identify the issues used for calculation (Adolphus, Alamina and Aderonmu, 2013).

The study also found several models of difficulty experienced by students in studying the topic of simple harmonic motion. 1. Students fail to build on existing knowledge in long term memory (DiSessa and Sherin, 1998; Frank, Kanim and Gomez, 2008).

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2. Students are wrong in arranging knowledge relevant to the problem (Hammer, 2000). 3. Students have difficulty in deciphering and operating mathematical equations such as when deciphering force on spring and pendulum (Adolphus, Alamina and Aderonmu, 2013). 4. Students experience confusion to understand the characteristics of simple harmonic motion in which there are some objects (Parnafes, 2010). It is important for students to have a proper understanding or understand of the concept of the concept at the beginning of the lesson.

Collaborative questioning is one model of learning that can improve understanding of physics concepts. The results of the study (Anderson, 2012) states that students who learn with questioning strategies have improved understanding of concepts better than inquiry methods. It is shown that students will be encouraged to optimize their thinking power through productive, systematic, directional, and profound questioning so that it is believed to be able to direct the formation of the correct concept (Aghekyan, 2015). (Kastner *et al.*, 2016) explains that the collaborative question and answer pattern in the discussion group will provide the interaction of adding or punishing concept justification to other students so that the formation of the physics concept becomes better. In addition, (Lupu, 2012) in his research also shows that learning collaborative learning can improve the understand of the concept without telling or explaining to the students. Nevertheless, at the end of the collaborative questioning lesson, there are still some students who are experiencing the problem of learning understand.

One effort that can be done to handle the problem of learning understand is by implementing web-based formative feedback. Providing web-based formative feedback is very important in the learning process (Burger and Nadirova, 2011). Providing appropriate target feedback has a positive impact on students (Valdez *et al.*, 2014). (Watson *et al.*, 2016) found that students would be motivated to straighten out thinking or behavior in understanding better concepts. This is supported by several research results that have been done by some previous researchers, namely (Gikandi, Morrow and Davis, 2011; Valdez *et al.*, 2014) who found that giving feedback (feedback) can increase learning motivation so that more confident and gain a better understanding . One other example is the study of increased learning outcomes conducted by (Sofianto, Wartono and Kusairi, 2016) which concluded that the provision of feedback affects student achievement. Students who were given formative assessments complete with their feedback had a higher average learning outcome than students who were not given feedback in their assessment (Valdez *et al.*, 2014).

Formative assessment is able to provide feedback required teachers to detect difficulties or levels of student understanding clearly, so that the feedback can provide improvements to improve students' concept of understanding, and can motivate students to learn better. Formative assessment using the multiple choice questions item is one of the types of formative assessments that are considered to be more helpful for students to know the lack or weakness of their understanding of the physics concept (Attali and van der Kleij, 2017)). In addition, formative assessments using multiple choice questions can also help teachers in providing more appropriate feedback to improve understanding or perform remedial programs more specifically (Singh, 2008). According to (Iron, 2008), the most effective feedback is the feedback given a few minutes after the students complete the task.

This study aims to apply the collaborative questioning strategy with web-based formative feedback and analyze the concept understand. Questions raised in this study are as follows. 1. How to master the concept of students on simple harmonic motion concepts that learn with collaborative questioning strategy with web-based formative feedback? 2. What difficulties are still experienced by students after learning with collaborative questioning strategy with web-based formative feedback ?

2 METHOD

This study uses mixed design methods with embedded experimental design developed by (Creswell, 2012). The subjects consisted of 34 students consisting of 7 male and 27 female students from X grade students of class MIA 2 Senior High School One Karangrejo academic year 2017/2018. The design used in this study is the research model One Group Pretest Postest, which is done pretest then subject to treatment in a row. After being given treatment, the subject is given a posttest to measure learning outcomes. Stages of the implementation of the study can be seen in Figure 1. The instrument used is a matter of double-choice options which consists of 9 questions. Indicator of each item can be seen in Table 1.

This is evidenced by the learning begins with working on the problem of right as much as 5 items in the web-based. Finished to do all the questions, students will get feedback in the form of a solution of the problems that have been done. Here are the

lessons learned during the class. First, learning begins with apperception activities, students are given a video about the pendulum associated with the characteristics of the motion that occurs to check their understanding taken from SMP whether it is correct or not about the concept of the direction of the restorer style on pendulum spring like Figure 2. Next the teacher asks the students discussion to answer, "Make an appropriate video question like in PowerPoint slides? "With its time to teach. The teacher asks the students to present the learning objectives that will be learned today in accordance with what has been discussed with their friends.

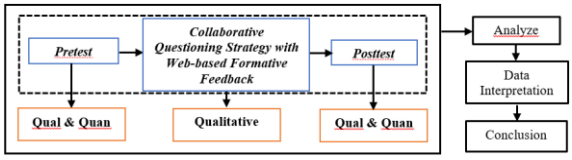

Figure 1: Mixed method research design with embedded experimental design (Creswell, 2012).

Figure 2: Children's video playing swing in the garden.

G : Have you ever played a swing in the park?
S1 : Yes, Ma'am
G : How did the swing move?
S2 : Direction of swing motion back and forth ma'am
S3 : This is because of the pull or push that is usually called the style
M : How did that happen?
S4 : If the pull or drive is given greater, then the swing will also swing higher and swing for a longer time repeatedly

Table 1: Problem item indicators.

Problem indicators	Number
Students can apply the period and frequency of the mass-spring system if different mass and deviation	1, 2
Students can determine the concept of position, speed and acceleration through the graph	5, 6, 7, 8
Students can compare the frequency and period of a simple swing if the mass and different angular deviations	3, 4
Students can compare the potential energy of two mass-spring systems that have the same initial deviation	9

The student's initial knowledge is correct, that is, if the attraction or encouragement is given greater, then the ayuna will also swing higher and swing for a longer time repeatedly. Second, the teacher asks the students to hold group discussions by answering the questions that are on the student worksheet as shown in Figure 3. Students conduct group discussions for 20 minutes.

Figure 3: Students discussing the direction of style of restorer.

Based on group discussions, students have understood the direction of the restoring force in pendulum. One member of the pendulum group conducts his time-to-teach discussion with one member of the spring group as Fig. 4.

Figure 4: Its time to teach.

Fourth, each student must record the concept that has been obtained in each notebook and write self-assessment in order to know the extent to which the understand of student concepts. Fifth, students do the tasks in the form of multiple-choice questions as much as 5 items in the web-based and finished doing all the questions, students will get feedback in the form of a solution of the problems that have been done. Sixth, students do multiple choice questions in order to strengthen the understand of the concept that has been owned and will be directly given feedback completed working on one problem and so on.

3 RESULT AND DISCUSSION

The value of students after working on the summation problem of simple harmonic motion shows the understand of the concept of simple harmonic motion. Students working on multiple choice questions reasoned with levels C2 to C5. Prior to use in the study, the item was validated by three experienced validators. The instrument used needs to be tested to know the quantity of statistics. Analysis of the instruments performed are different power and level of difficulty, correlation score of each item to the total score and reliability. Furthermore, the instrument consisting of 9 valid questions is analyzed reliability using Cronbach's Alfa. From the calculation results, obtained Cronbach Alfa value of 0.818. The value is included in the category of "very high".

Before being given research treatment, students are given a pre-test to know the student's initial ability. Here is a histogram of pre-test and post-test result of understanding of physics concept shown in Figure 5 and descriptive statistics Table 2.

Figure 5: Histogram of students' pre-test and post-test scores.

Table 2: Descriptive statistics pre-test and post-test concept understanding of students.

Variable	Pre-test	Post-test
Deviation Standard	1.045	1.152
Minimum	0	4
Maximum	4	9
Mean	1.18	6.35
Skewness	0.332	-0.502

*The score of the test scale is 0-9

The values of skewness on pretest and posttest are 0.332 and -0.502. The skewness value of the pretest and posttest data is greater than -1 and less than +1. so both data can be said normal distributed (Morgan *et al.*, 2004) because normal distributed hence can be tested using parametric test that is paired sample t-test. The results of paired sample t-test obtained significant values of 0.00 and less than 0.05 so that differences in pretest and posttest score is significant. Based on these results can be concluded that the understand of student concepts increased after learning with collaborative questioning with web-based formative feedback. The effectiveness of learning using collaborative questioning with web-based formative feedback can be seen based on the effect size and the average value of N-gain. The result of effect size and average N-gain calculation is presented in Table 3.

Table 3: Descriptive statistics pre-test and post-test concept understanding of students.

Statistics	Score	Category
Cohen's d-effect size	4.5	Vey high
Average N-gain	0.62	High

Ani and Dian played a swing with the same length of rope. Ani has a mass of 30 kg and Dian has a mass of 20 kg. If both children deviate the swing with the same initial deviation, the fastest up to the starting position is ....
A. Dian
B. Ani
C. Both come to the starting position simultaneously
D. Not enough information to answer questions
Reason:

Figure 6: Difficulties in the concept of pendulum frequency.

Table 4: Changes in student responses from pre-test to post-test: pre-test*post-test crosstabulation.

		Post-test				Total
		A	B	C*	D	
Pre-test	A	3	4	14	Not answering	21
	B	1	2	9	1	13
Total		4	6	23	1	34

*Correct answer

After learning with collaborative questioning along with web-based formative feedback, the students' correct answers increased to 23 students. This increase was followed by changes in student reasons that fit the scientific concept. From Table 4 can be explained 4 students answered the choice of A with the reason that the fastest to the starting position is Dian, because he has a smaller mass so he is easy to get ahead of Ani. The mass of a pendulum has an effect on the swing period. The lighter the swing mass the greater the period of a simple swing. 6 students answered option B with the fastest reason to get to the starting position is Ani, because he has a heavier mass than Dian. The larger the mass the greater the period. That the greater the mass the greater the period. 23 students answered option C with the reason which can be seen in Figure 7.

The swing frequency equation is $f = \frac{1}{2\pi}\sqrt{\frac{g}{l}}$

Comparison of swing frequency of two children playing swing is: $f_1 : f_2$

$$\sqrt{\frac{g}{l}} : \sqrt{\frac{g}{l}}$$

Figure 7: Students' reason for answered option C.

Based on the data, as many as 23 students answered correctly. However, the average student holds that the period of the swing is influenced by the mass of the swing. As many as 4 students answered A, students assumed that the mass of a pendulum had an effect on the swing period. The lighter the swing mass the greater the period of a simple swing. A total of 6 students answered B, the students assumed that the larger the mass the greater the period.

This student error is suspected because students are still difficult to distinguish the magnitude related to determine the spring period and swing period. Difficulties of students in differentiating magnitudes on simple harmonic vibrations according to research (Adolphus, Alamina and Aderonmu, 2013). Students are still having difficulty in solving simple harmonic motion problems due to lack of skills training in identifying the magnitudes on simple harmonic motion concept, the students only understand it not yet in the deeper stage of understand.

Based on the results of research that has been done through collaborative questioning strategy along with web-based formative feedback can improve the understand of the concept of simple harmonic motion. The results showed that the average value of N-gain of 0.65 (height) and effect size 4.52 which is in the category is very large. This shows that the application of collaborative questioning along with web-based formative feedback can improve students' conception comprehension significantly.

One of the causes of student difficulties is to distinguish quantities of periods and frequencies. Difficulties of students in differentiating magnitudes on simple harmonic vibrations according to research (Adolphus, Alamina and Aderonmu, 2013). Adolphus states, students still have difficulty in solving simple harmonic motion problems due to lack of skills training in identifying the quantities on simple harmonic motion concepts. Students understand only not yet in the deeper stage of understand. Formative assessment using the right items is wrong and multiple choice through web-based is one of the types of formative assessments that are considered to be more helpful for students to know the lack or weakness of their understanding of the concept of physics (Attali and van der Kleij, 2017). In addition, formative assessment using wrongly false and multiple-choice items can also help teachers in providing more accurate feedback to improve conceptual understanding more specifically (Singh, 2008). According to Iron (2008), the most effective feedback is the feedback given a few minutes after the students complete the task. Thus, providing web-based formative feedback can help students' difficulties in understanding the concept of simple harmonic motion.

According to (Atan *et al.*, 2011; Anderson, 2012) the application of collaborative questioning in the study of physics can improve students' better understanding of concept and able to build questions and skills to ask students and research conducted by (Burger and Nadirova, 2011) stated that the provision of formative feedback is very important in learning process. Web-based formative feedback is a means to help the student's concept forming properly because basically development and learning takes place while working on various practice questions. Activities of exchanging opinions and mutual learning in collaborative questioning have involved students to

develop thinking and improve conceptual understand through web-based formative feedback so that learning becomes more effective. Students who feel embarrassed to ask the teacher, can ask with friends in their respective groups. Therefore, it is necessary to do the learning with collaborative questioning strategy with web-based formative feedback to improve the understand of the concept of simple harmonic motion. Recommendations for further researchers, the authors suggest to do research in place of internet access smoothly so that later will facilitate students in following the learning through web-based.

4 CONCLUSIONS

Integrating web-based formative feedback to the collaborative questioning can help student to understand physics concept especially on harmonic motion. Student understanding will be better after learning. However there are still some difficulties experienced by students.

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