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Golabz-based interactive learning design about simple harmonic motion on pendulum swing

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Abstract: Physics learning about simple harmonic motion on a pendulum swing is interesting to be deeply learned because there are various physical quantities, practicum, formula derivation, and representation. In online learning, inquiry physics learning that provides independent practicum, online access, systematics, and interactive is needed. This research aims to design Golabz-based interactive learning and investigate its effect on students' understanding of simple harmonic motion on a pendulum swing. This research uses the R&D methods of the ADDIE type. The respondents were 7 second-year undergraduate students of the Department of Physics Education, UKSW, randomly chosen. The research instruments used are a validation sheet of material and media experts, an observation sheet, an evaluation sheet, and a questionnaire. All data gathered are analyzed using the qualitative descriptive technique. The result showed that the material and media met the eligibility criteria of 70,66% and 78,66%; all respondents can do 88,8% learning on average; all respondents can give positive responses of 89,79% on average in the questionnaire; and all respondents get evaluation score of 91,84% in average. Thus, Golabz-based interactive learning design is adequate to help students understand simple harmonic motion on a pendulum swing and can be one of the alternative online learning that presents interactive inquiry learning.

Keywords: Golabz, Interactive Learning, Simple Harmonic Motion, Pendulum Swing

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INTRODUCTION

Learning physics about simple harmonic motion on pendulum swings is one of the exciting physics materials to study in depth because it has high complexity marked by variations in physical quantities, practicum, derivation of formulas, and quite a lot of representations for students to work on and understand (Firdausi & Purwaningsih, 2017). Learning simple harmonic motion on pendulum swings is still limited to deriving formulas and practising in the classroom (Adolphus, Alamina, Aderonmu, Education, & State, 2013). In addition, most students still have a weak understanding of terms, lack skills in identifying parameters needed in calculations, and lack confidence in solving simple harmonic motion problems (Sugara et al., 2016). Aprilia's research (2015) states the same thing, namely that students' understanding and mastery of concepts is still weak (Aprilia, 2015). On the other hand, several studies on physics learning that were carried out online during the Covid-19 pandemic explained that the learning situation was not conducive, so there were difficulties for educators in transferring the subject matter to students (Napsawati, 2020). Educators struggle to communicate and have intense discussions with students, and students have difficulty focusing on learning (Fauza, Ernidawati, & Syaflita, 2020). Educators also experience difficulties explaining physical equations, resulting in low students' ability to solve math problems, and educators have difficulty implementing learning that requires practicum (Mahardini, 2020). The same thing was expressed by Permata et al. (2020), who examined virtual class-based online physics learning using Google Classroom, namely that physics learning was impractical because of the limitations of learning through the practicum. Learning physics during a pandemic, which made online learning one of the main alternatives, became increasingly challenging, especially in material that required practicum, including simple harmonic motion on a pendulum swing. Thus, during the Covid-19 pandemic, to support more effective learning, interactive learning media is needed to support the success of learning physics (David R. Sokoloff, 2013).

Interactive learning media has practical values in the ability to generate student learning motivation, present learning information consistently and can be repeated or stored as needed, and present messages or information simultaneously over space and time (Putri, Risdianto, & Rohadi, 2019). Therefore, interactive learning media can facilitate understanding of the material and make learning more enjoyable. In addition, the use of well-designed interactive learning media involving graphics, audio-video and interaction will increase the effectiveness of material absorption by up to 80-90% (Wibawanto, 2017). The collaboration of interactive learning media with internet networks and the role of supporting technology enables learning to increase student learning motivation (Sibero, 2011). For this reason, physics learning media needs an inquiry step, provides independent practicum, can be accessed online, is coherent in learning steps, and is interactive so that it can answer the challenges of the learning process during the Covid-19 era. One of the media that can be an alternative to answer this challenge is Golabz (Graaf & De Jong, 2020).

Using Golabz, interactive learning designs can be designed and learning spaces available for students that provide various learning platforms enabling collaboration between educators and students (Jong, Sotiriou, & Gillet, 2014). Aside from being a learning space, Golabz has functions and uses as an online laboratory and application that offers experiments on scientific learning activities. The use of Golabz-based interactive learning designs with computers allows the creation of a learning environment with an inquiry process (Hovardas & Zacharia, a.n.d., 2018). One of the Golabz-based interactive learning designs is to use an Inquiry Learning Space (ILS). ILS enables scientific learning (ÇORLU & ÇORLU, 2012) and can be applied in online learning processes or virtual classes. ILS can combine documents, presentation slides, videos, images, and links that educators can design themselves (Dikke et al., 2014). The Golabz-based interactive learning design offers a coherent learning phase from the orientation, conceptualization, investigation, discussion, and conclusion stages to create inquiry and interactive learning (Pedeste et al., 2015). In inquiry learning, practicum often cannot be ruled out. ILS on Golabz allows independent practicum integration. In physics learning before the Covid-19 pandemic, simulations could be an alternative learning media with limited laboratory equipment or time. Learning that involves simulations for students can provide learning experiences with artificial situations to understand concepts, principles, or facts (Saputra et al., 2020). Previous studies stated that PhET simulations are effective in helping students understand physics materials where the physical quantities are pretty abstract (Karanggulimu, Sudjito, & Noviandini, 2017) (Dinavalentine, Noviandini, & Sudjito, 2016) (Situmeang, Sudjito, & Wibowo, 2019) (Ariyani, Sudjito, & Pattiserlihun, 2020). PhET simulation can also be integrated into ILS Golabz, so practicum is possible here. Thus, the Golabz-based interactive learning design can be an alternative to online learning for simple harmonic motion on pendulum swings.

In this study, we investigated how to make Golabz-based interactive learning designs about simple harmonic motion on pendulum swings and how the effectiveness of Golabz-based interactive learning designs on students' understanding of simple harmonic motion material on pendulum swings. This study aimed to design Golabz-based interactive learning media and investigate the effectiveness of Golabz-based interactive learning designs on students' understanding of simple harmonic motion material on pendulum swings. The benefit of this research is to present an interactive alternative solution for learning physics online that integrates practicum during the Covid-19 pandemic and enriches the collection of Golabz-based interactive learning designs, especially about simple harmonic motion on pendulum swings.

METHODS

This research is ADDIE-type development research. This method was chosen because this type can be used in a variety of making and developing learning products such as models, strategies, methods, especially media and teaching materials. In addition, the ADDIE type is a model that emphasizes an interactive learning process with the primary stages of effective, dynamic and efficient learning relevant to this research (Branch, 2019). The ADDIE stages consist of the Analysis, Design, Development, Implementation, and Evaluation steps, as shown in Figure 1.

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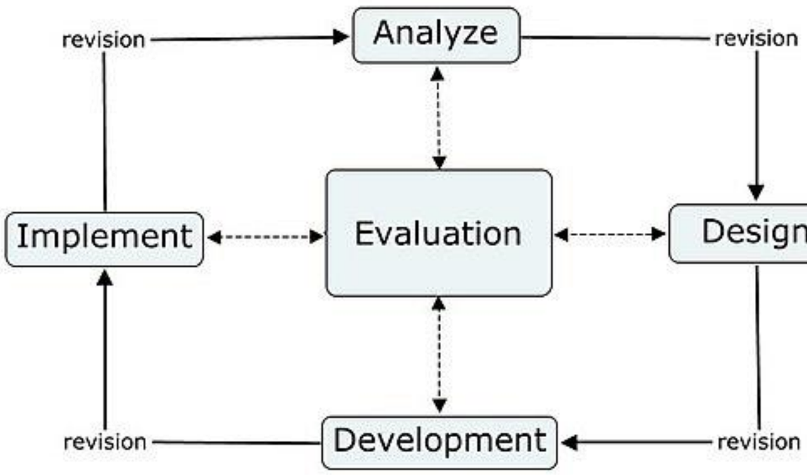

Figure 1. ADDIE stage of Product Development

Respondents to this research were randomly selected from 7 sophomore students in the Satya Wacana Christian University (SWCU) Physics Education Study Program. The research instruments used were material expert and media expert validation sheets, observation sheets, evaluation questions, and questionnaire sheets. Material expert and media expert validation sheets are used to seeing the feasibility of the Golabz-based interactive learning design. Observation sheets are used to record the progress of learning. Evaluation questions are used to see how much students understand the learning material—a questionnaire sheet is used to see student responses to interactive learning designs based on Golabz.

Analysis

At the analysis stage, needs, curriculum, and student character analyses are carried out. A needs analysis was conducted first to analyze the primary needs in physics learning attended by students online during the Covid-19 pandemic. Curriculum analysis was carried out to identify learning outcomes in wave vibration courses. Furthermore, student character analysis is carried out to see the condition of students during online learning that has been going on during the Covid-19 pandemic, such as the availability of laptops or smartphones, smooth internet access, as well as the benefits and difficulties during online learning (Branch, 2019).

Design

At this stage, an interactive learning design based on Golabz was created. At Golabz, ILS was chosen, integrating inquiry learning syntax, namely Orientation, Conceptualization, Investigation, Discussion, and Conclusion. At each stage of the activity, students are designed to be able to carry out interactive self-learning, primarily through accompanying sentences or statements. Independent practicum is also integrated with PhET simulations and Walter Fendt Pendulum simulations. Furthermore, so that there is interaction with educators if students experience difficulties, a chat application from Golabz is installed. In addition to the Golabz-based interactive learning design, validation sheets, observation sheets, evaluation questions, and questionnaires were also made.

Development

After the Golabz-based interactive learning design has been created, this design is validated by material experts and media experts to determine the feasibility of the design. Material validation aspects consist of curriculum aspects, material presentation aspects, evaluation aspects, and language aspects. In contrast, media validation consists of content feasibility, linguistic, graphical and presentational aspects (Ariyani, Sudjito, & Pattiserlihun, 2020). Guided validation for Content Expert can be seen in the Table 1.

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Table 1. Content Expert Validation Guided

Aspect	Indicators
Curriculum	Suitability of learning objectives
	The clarity of the formulation of learning objectives
	The truth of the material concept, in terms of scientific aspects
Content Presentation	Conformity of the concepts described with the concepts put forward by physicists
	The material is well organized so that it helps students understand the material
	Suitability with student cognitive development
	Material relations in everyday life
Evaluation	The appropriate form of evaluation with the material and learning objectives
	The suitability of the evaluation form with the concept presented
	The suitability of the difficulty level of the questions with the learning objectives
	The suitability of the variation of questions with the level of difficulty of the questions.
Language	Use of communicative language
	Accurate use of terms
	The suitability of the use of language with the level of development of students
	Sentences are easy to understand

Guided validation for Media Expert can be seen in Table 2.

Table 2. Media Expert Validation Guided

Aspects	Indicators
Content Eligibility	Conformity with learning outcomes
	Suitability with student development
	Compatibility with the needs of teaching materials
	The truth of the substance of learning material
	Useful for adding insight
Language	Ease and simplicity in reading
	Clarity of information conveyed
	Compliance with good language rules
	Conformity with the rules of writing
	Clarity of writing
Graphics and Presentation	Appropriateness of the format, layout or layout and images, videos that are presented with media displays
	The clarity and suitability of the illustrations, pictures and videos
	Compatibility of features
	Display design compatibility
	Clarity of display order and completeness of the information

The score of the material expert and media expert validation sheet uses a Likert scale of 1-5, with the lowest scale being 0 and the highest scale being 5. The validation score is then calculated using equation 1.

$$\%\,\text{eligibility} = \frac{Score}{n} \times 100\%$$

Furthermore, to determine the design eligibility criteria and categories, the results of material and media expert validation are reviewed based on Table 3.

Table 3. Media eligibility criteria and categories

Media Eligibility Percentage (%)	Criteria	Category
81-100	Excellent	No revision
61-80	Very Good	Minor revision
41-60	Good	Partial revision
21-40	Fail	Mayor revision
<21	Poor	Total revision

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The validation results from material and media experts are taken into consideration and used as a basis for developing or revising Golabz-based interactive learning designs. After obtaining a minimum percentage of criteria and categories of 61%, interactive learning designs based on Golabz can be applied to learning (Sugiyono, 2015). Determining the feasibility of learning media according to Chaeruman (2015), namely (1) a media can be said to be substantively feasible if the material is correct and there are no conceptual errors; (2) achieving an average score of ≥ 3.00 on a scale of 1-5 seen from the aspects of curriculum, learning design, and learning communication. Determining the feasibility of learning media refers to Figure 2.

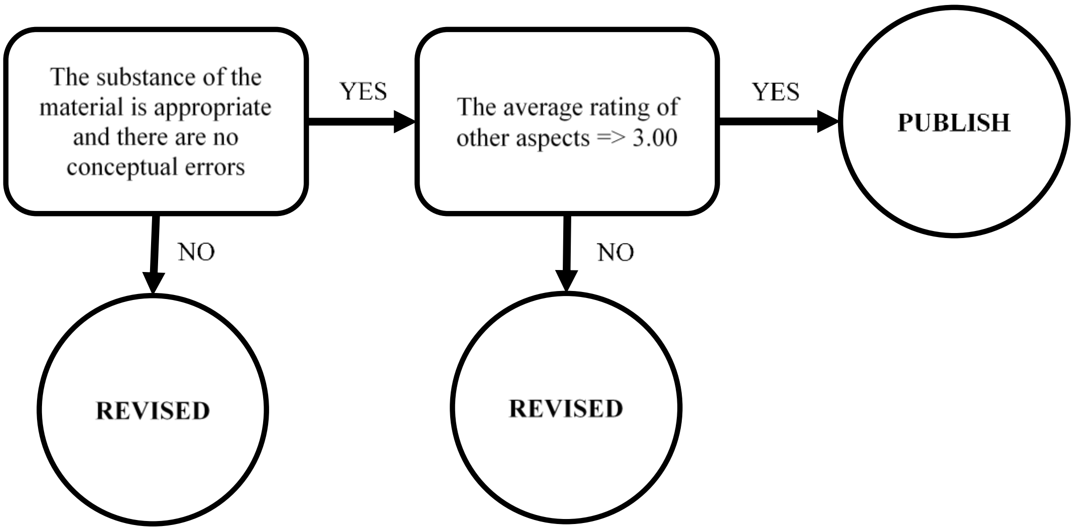

Figure 2. Determination of Eligibility (Grading System) Media

Implementation

After the Golabz-based interactive learning design was declared feasible, the design was applied to the respondents of this study. Learning was conducted online by sharing interactive learning design links from Golabz to respondents and observers. When the respondent learns to use an interactive learning design based on Golabz from the respondent's account, the observers observe the course of learning through the Golabz page from the observer's account and fill out the observation sheet. Respondents answered tests and filled out questionnaires at the end of the lesson. In addition, interviews with respondents were also conducted to investigate the phenomenon in depth.

Evaluation

All data collected from validation sheets, observation sheets, evaluation questions, and questionnaires were analyzed descriptively and qualitatively to determine the effectiveness of the Golabz-based interactive learning design on students' understanding of simple harmonic motion on pendulum swings (Hardani et al., 2020). In the next step, all the data were analyzed for the percentage of effectiveness using equation (2); P is a percentage of achievement scores, f is the total score obtained, and N is the maximum total score.

$$\mathrm{P} = \frac{f}{N} \times 100\% \qquad (1)$$

The calculation results will be categorized to determine the success of the designed learning design. An interactive learning design based on Golabz is said to be effective if (1) the results of the validation of materials and media meet eligibility at least 70%; (2) based on the results of observations, respondents can do at least 70% of learning; (3) all respondents gave positive feedback on at least 70% of the questionnaire statements; and (4) all respondents get a minimum score of 70 out of the highest score of 100 on the evaluation question.

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RESULTS AND DISCUSSION

Analysis

The needs analysis results indicate that simple harmonic motion on a pendulum swing can be conducted by practicum to facilitate student understanding concept in learning; skilled at identifying the parameters needed in calculations, and problem-solving skills. In addition, during the Covid-19 pandemic, a learning design was needed to integrate online practicum, inquiry learning to hone problem-solving skills, and interactive and accessible learning. Then, the analysis curriculum specifically wants students to define the meaning of simple harmonic motion and determine and analyze the physical quantities of motion in a pendulum swing. Furthermore, the student character analysis showed that students had been accustomed to online learning activities since the Covid-19 pandemic (about 10 months ago). Students have a computer, laptop, or smartphone and an adequate internet connection. These three analyses underlie the creation of an interactive learning design based on Golabz made in this study.

Design

In this learning design, there are two learning objectives to be achieved; namely, students can (1) define the meaning of simple harmonic motion; (2) determine and analyze the physical quantities of simple harmonic motion in a pendulum swing. The two main activities are designed to facilitate students in achieving the two learning objectives.

<u>Activity 1. Define the Meaning of Simple Harmonic Motion</u>

Orientation stage, students are assigned to observe a video and then provide predictions about the types of motion contained in the video. This activity is expected to foster initial concepts of the material being studied. In the conceptualisation stage, students give predictions about the characteristics of periodic or harmonic motion. In the Investigation Stage, students observe 3 videos that contain alternating motion and provide descriptions of the motions in all videos, and then, students can provide predictions about which videos have linear and angular trajectories. In the Discussion stage, students are confirmed the similarity of features, the shape of the trajectory of motion, travel time, and the points that are always passed during movement based on observations from the three videos in the Investigation stage. Conclusion stage, a conclusion from the understanding of simple harmonic motion is given.

<u>Activity 2. Determine and Analyze Physical Quantities in the Motion of a Pendulum Swings</u>

In the Orientation Stage, students observe a video similar to the one in the Orientation stage in Activity 1. Students are assigned to provide predictions from the physical quantities of a pendulum swing that can be measured. In the conceptualisation stage, students are assigned to provide predictions on how to determine the physical magnitude of the pendulum swing. In the Investigation Stage, students are assigned to analyse the magnitude of the deviation, amplitude, frequency, period, restoring force, acceleration, speed, and energy through experiments. Analysis was also carried out on the pendulum swing images for positions B, C, D, and E based on the image analysis exemplified in position A. In the Discussion stage, students were given confirmation accompanied by a simulation of the physical magnitudes of the pendulum swing. In the conclusion stage, conclusions are given on how to determine and analyze the physical quantities in the pendulum swing.

After completing Activity 1 and Activity 2, evaluation questions and questionnaires are given through Golabz. Learning can be interactive between educators and students, the chat feature is integrated. So if students experience difficulties, they can discuss them with educators via chat.

Development

At this stage, the Golabz-based interactive learning design that has been made is validated by material experts and media experts. The validation results are shown in Table 4.

Table 4. Results of Validation by Expert Judgement

Item	Material	Media
Percentage	70, 66%	78,66%
Average Score	3,53	3,93

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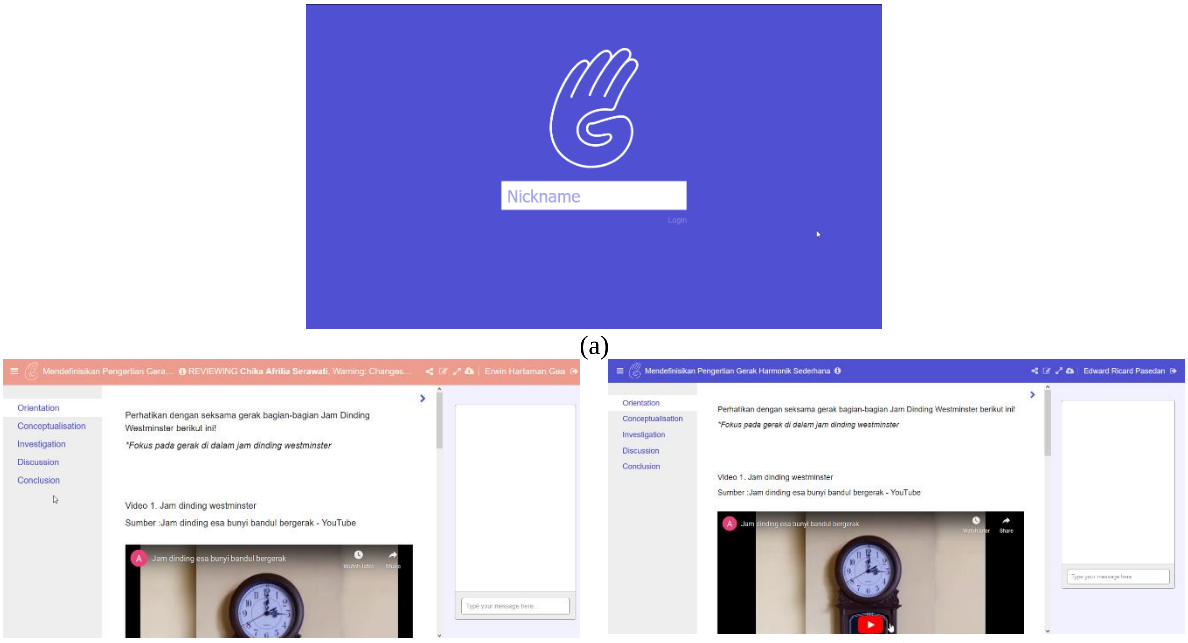
Item	Material	Media
Feasibility	Feasible to use	Feasible to use
Categorize	No revisions or partial revisions	No revisions or partial revisions

Table 4 shows that learning materials and media are feasible for use without revision or partial revision. The validator suggests several revisions and those that have been carried out include (1) clarifying the concurrent sentences in the form of activity instructions; (2) including the source of the video used; (3) reducing the number of videos used in the Golabz design so that the substance of the learning objectives is right on target; and (4) clarify the concept of slight deviation ($0° < \boldsymbol{\theta} \leq 10°$) as a condition of the pendulum swinging motion which acts as simple harmonic motion. After that, the Golabz-based interactive learning design is applied or implemented in classroom learning.

Implementation

Activity 1. Define the Meaning of Simple Harmonic Motion

The display of Golabz-based interactive learning design media for Activity 1 is shown in Figure 3.



(a)

(a) (c)

Figure 3. Display of the Golabz page for Activities 1. (a) Golabz page login display; (b) The display of the respondent's page is pink; (c) The observer page display is dark blue.

Orientation

Students observe a video, and then two questions are asked, namely (1) What kinds of movements can you observe in the video?" and (2) "What motion is experienced by the pendulum on the Westminster wall clock?". Students write their answers in the box provided. All students answered correctly, namely (1) The pendulum's motion back and forth on a clock or periodic motion, but three out of seven students added their observations, namely clockwise circular motion and (2) alternating motion. Based on the results of observations, at the Orientation stage, all students were able to answer the questions correctly. It means that the activities designed have successfully directed students to learn simple harmonic motion (back and forth motion).

Conceptualization

Students are asked, "What are the characteristics of periodic motion or harmonic motion?" and write their answers in the box. All students answered correctly by giving one of the answers from (a) The motion of objects is periodic or regular back and forth at the same time; (b) Always pass the equilibrium point; (c) The deviation is proportional to the restoring force; (d) Have the same amplitude and frequency. Based on the results of observations at the Conceptualization stage, all students gave predictions about the characteristics of simple harmonic motion.

Investigation

There are three videos about various types of back-and-forth motion, namely (1) swings, (2) plucking guitar strings, and (3) car shock breakers. Students are given three questions based on observations of three types of alternating videos, namely (1) "Try to describe each of the alternating motions contained in the three videos", (2) "Does the alternating motion in the video include periodic motion or harmonic motion. If yes, why do you think so?”, and (3) “Group which reciprocating motion has a linear or angular trajectory based on the three videos”. Students write their answers in the tables or boxes provided. All students gave the correct answers, namely (1) describing each of the videos, where the first video is the motion of the pendulum swing being pushed or pulled so that the swing moves back and forth or periodically, the second video is the vibration of a guitar string that experiences up and down or vibrates repeated with a specific frequency, and the third video of the movement of the shock breaker on a car that is moving up and down; (2) Yes, because the three videos experience alternating motions left and right and up and down; (3) the first video is about a swing with an angular motion trajectory, the second video is about the vibration of a guitar string with a liner track, and the third video is about a shock breaker on a car with a liner track. Based on the results of observations, in the Investigation stage, all students can answer and describe their observations correctly and distinguish angular or linear harmonic or periodic motion. It means that the activities designed are successful in helping students to distinguish harmonic motion that occurs in several objects.

Discussion

Based on the three videos in the Investigation stage, students were asked five questions, and they wrote down the answers in the boxes provided. The first question is, "What do these three motions have in common so that they can be called periodic (alternating) or harmonic motion?" All students answered correctly from one of the answers (a) The three videos experience alternating motion or (b) The movement of objects always passes through an equilibrium point. The second question, "Are the three movements an alternating motion?" Six of the seven students answered correctly, namely "Yes", but one did not answer. The third question is, "Is the back-and-forth motion taken simultaneously?" Five of the seven students answered correctly, namely "Yes", but one answered incorrectly and the other did not. The fourth question is, "Is there the same point passed when the back-and-forth motion occurs?" All students answered correctly, "Yes, there is one point that is skipped during the back-and-forth motion of the three videos". The fifth question, "Which motion is included in simple harmonic motion?" Six out of seven students answered correctly, namely a video about swing motion, but one did not answer. Based on observations, in the Discussion stage, most students (71%) could answer the questions correctly, so activities designed to consolidate the concept of alternating motion succeeded in helping students understand the definition of simple harmonic motion.

Conclusion

Students are given three questions to conclude the characteristics of simple harmonic motion, namely (1) "What are the characteristics of periodic motion or harmonic motion?", (2) What are the characteristics of simple harmonic motion? (3) "Find at least two examples of the motion application each. harmonics and simple harmonic motion in everyday life!” Students write their answers in the boxes or tables provided. All students answered correctly, namely (1) Repeated motion at the same time interval and through the equilibrium point; (2) Simple harmonic motion is a harmonic motion that has the same amplitude and frequency; (3) All students can give each of two examples of harmonic motion and simple harmonic motion. Based on the observation results, in the Conclusion stage, all students can answer correctly, so the activities designed are successful in helping students deduce the characteristics of simple harmonic motion. The results indicate that activity 1 can be helped 71% of students define the meaning of simple harmonic motion.

Activity 2. Determine and Analyze Physical Quantities in the Motion of Pendulum Swings

The display of Golabz-based interactive learning design media for Activity 2 is shown in Figure 4.

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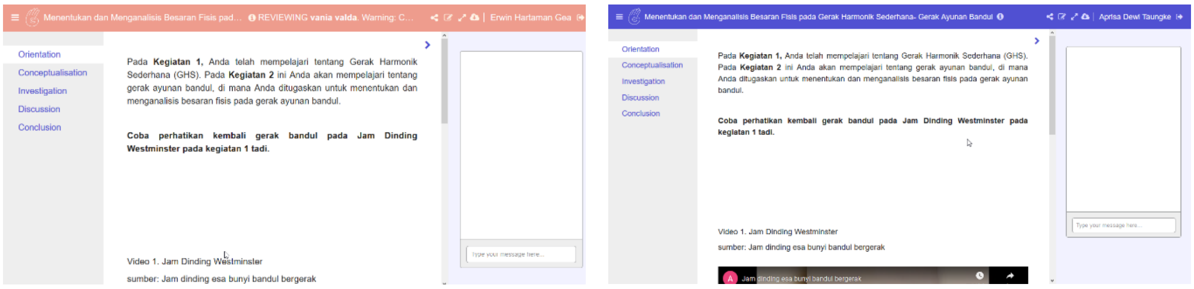

(a) (b)

Figure 4. Golabz page display for Activities 2. (a) The display of the respondent's page is pink; (b) The observer page display is dark blue.

Orientation

Students again observed the Westminster wall clock in Activity 1. Students are asked, "What are the physical quantities in the pendulum swing that can possibly be measured?" and write their predictions in the box provided. All students succeeded in answering by giving predictions, namely deviation and amplitude, frequency and period, restoring force, acceleration, velocity, and energy. Based on the results of observations, in the Orientation stage, all students can provide predictions about the physical quantities on the pendulum swing. It means that the activities designed have succeeded in directing students to study the physical quantities in the motion of a pendulum.

Conceptualization

Students were asked about "How to determine and analyze the physical quantities in a pendulum swing?" and wrote their answers in the box provided. Six out of seven students gave predictions that through the pendulum swing experiment, an analysis of physical quantities was carried out at certain positions, and one of them did not answer. Based on the results of observing learning activities in the conceptualization section, most of the students succeeded in answering by providing predictions about how to determine and analyze the physical quantities on the pendulum swing.

Investigation

At this stage, students are assigned to conduct experiments to determine and analyze the deviation, amplitude, period, and frequency, restoring force, acceleration, speed, and energy in the pendulum swing.

Deviation and Amplitude. Students are shown a picture of the position of the pendulum swing at five points, namely A, B, C, D and E. Based on the picture, students are asked the question, "How do you determine and analyze the deviation and amplitude of the pendulum swing?" and students write their answers in the box provided. Six of the seven students answered correctly, namely the C-B and C-D intersection positions and the C-A and C-D amplitude positions, but one did not answer.

Periode and Frequency. Students are assigned to carry out two experiments to determine the period and frequency of the pendulum swing for angles of 2°,4°,6°,8°, and 10° with PhET simulations. All students experimented wholly and correctly, as seen from their observations, namely the acquisition of the time results read on the stopwatch.

Restoring Force. Students were given two questions, namely (1) "Why does the pendulum move to the right when it is pulled to the left and released?" and (2) “Is there a force influencing it? If so, what style is it? If not, what physical quantities affect it?” Then they are given an example of force analysis for the pendulum position at A. They are assigned to analyze what forces are acting on the pendulum swing at positions B, C, D and E based on the analysis of the forces in position A. For positions B and C, six students drew the restoring force vector on the free body diagram and analyzed it correctly. For positions D and E, two students drew and analyzed the styles correctly; four drew the force correctly but did not include a minus sign when analyzing the force, and one answered incorrectly. At the end of this section, students are assigned to summarize the restoring forces for the pendulum swinging in the five positions based on the force analysis they did before. All students can answer this part correctly.

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Velocity. Students were given two questions, namely (1) "What acceleration affects the swing of the pendulum?" and (2) How do you determine the acceleration of a pendulum?" In line with the previous section, students take an example of acceleration analysis for the pendulum position at A. Then they are assigned to analyze the acceleration of the pendulum swing at positions B, C, D and E based on the analysis at position A. For position B, all students draw an acceleration vector on the pendulum and analyze it properly. For position C, three students correctly drew the acceleration vector on the pendulum, and six students analyzed the acceleration on the pendulum. For positions D and E, all students drew the acceleration vector on the pendulum and analyzed it correctly, but four did not include the minus sign when analyzing the acceleration. At the end of this section, students are assigned to summarize what accelerations are experienced by the pendulum swing in the five positions based on the acceleration analysis they did before. Six students can answer this part correctly, namely tangential acceleration and centripetal acceleration.

Velocity. Students were given two questions, namely (1) "What velocity affects the swing of the pendulum?" and (2) "How do you determine the velocity of a pendulum?" Students were again given an example of velocity analysis for the pendulum's position at A. Then they were assigned to analyze the velocity of the pendulum's swing at positions B, C, D and E based on the analysis at position A. For position B, six students drew a velocity vector on the pendulum and analyzed it using Correct. For position C, four students correctly drew the velocity vector on the pendulum, and two students analyzed the acceleration of the pendulum. For position D, one student correctly draws the velocity vector on the pendulum, and five students analyze the pendulum's velocity. For position E, all students could not draw the velocity vector on the pendulum correctly, and five students gave the velocity analysis on the pendulum correctly. At the end of this section, students are assigned to summarize what speeds are experienced by the pendulum swing in the five positions based on the speed analysis they did before. All students can answer this section correctly, namely linear and angular velocities.

Energy. Students are given two questions, namely (1) "What energy affects the swing of the pendulum?" and (2) "How do you determine the energy of a pendulum swing?" Students were again given an example of energy analysis for the pendulum position at A. Then they were assigned to analyze the energy of the pendulum swings at positions B, C, D and E based on the analysis at position A. For position B, there were two students, and for position C there were six students. For position D, there were two students; for position E, five students correctly analyzed the pendulum's energy. At the end of this section, students are assigned to summarize any energy experienced by the pendulum swing in the five positions based on the energy analysis they did before. All students can answer this part correctly, namely potential and kinetic energy.

Based on the results of student learning in the e-module, it was found that all students had no difficulty in determining the deviation, amplitude, period, and frequency of the pendulum swing. Exciting things happened when they analyzed the pendulum swing as restoring force, acceleration, speed, and energy. 86% of students have no difficulty drawing and analysing force vectors in all positions. However, half of the students had difficulty describing the acceleration and velocity vectors in positions C and D, and even in position E, no student answered correctly for speed. In energy analysis, 71% of students have difficulty in positions B and D. In learning; teachers need to emphasise analysis in positions that are not often discussed in references so that students get a comprehensive understanding.

Discussion

For each physical quantity investigated, students confirmed the correct answer with explanations, pictures, graphs, and a simulation of the Walter Fendt pendulum and then asked to see their answers in the Investigation step so that they realized their answers were not correct.

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Conclusion

Students are assigned to conclude how to determine and analyze the deviation and amplitude, period and frequency, restoring force, acceleration, velocity, and energy in the pendulum swing. Then the students confirmed their conclusions. After completing Activity 1 and Activity 2, evaluation questions and questionnaires are given through Golabz.

Observation sheets

During the learning activities, the observer filled out the observation sheet online to record the learning process with the help of the standalone user feature. The results of observing learning activities can be seen in Table 5.

Table 5. Observation Results of Activities 1 and 2

No.	Name	The percentage of success of the learning process		Total (%)
		Activity 1 (%)	Activity 2 (%)	
1.	A	92,8	61,1	76,9
2.	B	98,2	97,2	95,0
3.	C	100,0	80,5	90,2
4.	D	100,0	91,6	95,8
5.	E	100,0	72,2	86,1
6.	F	92,8	80,5	86,8
7.	G	92,8	88,8	90,8
		Average		88,8

Table 5 shows that in Activity 1, all students got percentages above 90%, meaning that almost all students succeeded in defining the meaning of simple harmonic motion. In comparison, for Activity 2, 86% of students got percentages above 80%, meaning that most students succeeded in determining and analyzing the magnitude of the physics of motion in a pendulum swing. Overall, all students successfully carried out learning activities correctly because they had achieved a minimum percentage of 70%, with an average success rate of 88.8%; even 57% of students can do more than 90% of learning activities correctly. It means that the created Golabz-based interactive learning design has successfully guided students to carry out online learning correctly, coherently, independently, and interactively.

Evaluation Test

After learning, students are given online evaluation questions via Golabz to determine their understanding of simple harmonic motion in a pendulum swing. To calculate the evaluation value, you can use equation (2). The evaluation results can be seen in Table 6.

Table 6. Results of Evaluation

No.	**Name**	**Score**
1.	A	73,0
2.	B	95,0
3.	C	80,0
4.	D	90,0
5.	E	97,0
6.	F	87,0
7.	G	88,0
Average		87,2

Table 6 shows that all students got scores above 70 with an average of 87.2. It means that students succeed in understanding the material after studying with an interactive Golabz-based learning design that is conducted online and independently.

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Questionnaire Sheets

After students have finished working on evaluation questions, students are given a questionnaire to see their responses to the Golabz-based interactive learning design through the Google Form, which is integrated into Golabz. There are 7 statement items, items 1 and 2, regarding student enthusiasm in learning activities using Golabz-based interactive learning designs and whether learning using media with Golabz-based designs helps them understand the material. Items 3-5 regarding the contents of the Golabz-based interactive learning design, namely font type, font size, image colour, information and sentences used in the Golabz-based interactive learning design. Item 6 regarding implementation instructions in the form of steps of learning activities that are followed. Item 7 regarding the material explained in the Golabz-based interactive learning design, whether the material is boring or not. To calculate the percentage of student assessment of interactive learning based on the Golabz design that has been given, you can use equation (2). The percentage of student responses to learning can be seen in Table 7.

Table 7. Questionnaire Results

Item	Number of Students Giving Positive Responses to Questionnaire Items (%)
1	85,70
2	85,70
3	100,00
4	100,00
5	71,40
6	100,00
7	85,70
Average	89,79

Table 7 shows that more than 70% of students responded positively to all questionnaire statements, averaging 89.79%. Several interviews were conducted with students to clarify their responses to the questionnaire. All students were enthusiastic about doing Golabz-based interactive learning independently and stated that it helped them understand the material provided. Students say that learning with Golabz design media can help them understand the material. Students assess that the letters and colours of the images in the design are easy to understand and read, the Golabz design provides clear information on how to implement learning, and the sentences used in the Golabz design are easy to understand. The steps and explanations of learning with a Golabz-based design are coherent, orderly and effective in helping students to understand simple harmonic motion material on pendulum swings, and the material included in the Golabz-based design is not boring. It means that the created Golabz-based interactive learning design has successfully guided students to carry out online learning correctly, coherently, independently, interactively, and enthusiastically.

Evaluation

After all data from all research instruments were analyzed, the following results were obtained: (1) The validation results for materials and media met the minimum eligibility criteria of 70%, namely 70.66% for materials and 78.66% for media; (2) The results of learning observations show that all respondents can do the learning correctly at least 70% with an average of 88.8%; (3) All respondents gave positive responses to at least 70% of the questionnaire statements with an average of 89.79%; and (4) All respondents got a minimum score of 70 out of the highest score of 100 on the evaluation questions with an average of 87.2%. Thus, all indicators of success are achieved, and the Golabz-based interactive learning design can be effective in helping students understand simple harmonic motion material on pendulum swings.

CONCLUSION

Based on the research results, it was found that: (1) Material and media met the eligibility criteria of 70.66% and 78.66% (2) All respondents could do the learning correctly with an average of 88.8%;

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(3) All respondents gave positive responses to the questionnaire statements with an average of 89.79%; and (4) All respondents get evaluation scores above 70 with an average of 87.2%. So the Golabz-based interactive learning design can be effective in helping students understand simple harmonic motion material on pendulum swings. Thus, the Golabz-based interactive learning design about simple harmonic motion on pendulum swings can be used as an alternative to online learning during the Covid-19 pandemic, which presents inquiry learning, provides independent practicum, and can be accessed online, coherently, and interactively. For further research, the supporting application features contained in ILS Golabz can be used more, and developing this design for other physics materials is highly recommended.

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