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E-module design based on Golabz for online physics learning about RLC series circuits

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Abstract: There are many virtual physics laboratory applications, i.e., Golabz and Crocodile Physics. This study aims to design online physics learning about RLC series circuits using Golabz, which integrates Crocodile Physics and investigates its effectivity on students' understanding. The research method used here is the development research with the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The online physics learning design based on an inquiry about the RLC series circuit using Golabz consists of three learning activities according to the learning objectives. Each learning has five steps, i.e., orientation, conceptualization, investigation, discussion, and conclusion. The research instruments are an observation sheet, evaluation, questionnaire, and validation sheet for the material and media. Based on the research above, the results of learning observation indicate that all respondents can follow the learning well with an average of 82% and gave positive responses to at least 70% of the statements with an average of 98%; some students were able to obtain evaluation results of more than 70% with an average of 71.88%. Thus, all indicators of success are achieved, and the online physics learning design about RLCseries circuits using Golabz is said to be sufficient to help students understand the material of RLC series circuits.

Keywords: Crocodile Physics, Golabz, RLC series circuit, virtual laboratory.

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INTRODUCTION

The Covid-19 pandemic has had a considerable impact and is felt in almost all areas of life, one of which is education. The Government of Indonesia, through the Ministry of Education and Culture, has also issued Circular Letter Number 3 of 2020 concerning the Prevention of Covid-19 in Education Units in anticipation of the Corona Virus Disease 2019 (Covid-19) in various schools and universities. The circular contains alternative learning, usually done face-to-face, replaced with online learning at home. Online learning aims to reduce the spread of Covid-19. On the other hand, educators must continue to provide maximum learning with all existing policies and limitations.

The Circular requires teachers to design teaching and learning activities using the concept of e-learning. By definition, e-learning is learning that is structured to use an electronic or computer system so that it can support the learning process (Allen, 2016). In addition, e-learning is also in line with the industrial revolution 4.0 in the field of education, where educators and students are encouraged to use digital technology in learning, including physics. In the end, more and more education actors realize that e-learning is effectively used because it can be accessed anywhere and anytime (Setiaji & Dinata, 2020).

Physics learning for higher education levels generally uses a scientific approach that involves students actively using the scientific process and creative scientific skills as they find answers to the questions posed (Husnaini & Chen, 2019). In line with this, inquiry-based learning models are becoming increasingly popular because of the processes in learning activities that train students to investigate and explain unusual phenomena. Thus, learning activities need to apply this learning model so that students have skills in finding and finding solutions to a problem (Joyce et al., 1999). Inquiry-based learning emphasizes the active participation and responsibility of students to discover new knowledge for students (de Jong & van Joolingen, 1998). One of the learning methods under the inquiry learning model is a practicum.

Learning with practical methods can increase the mastery of concepts for students. Practicum can also make students able to understand the concept and the nature of science as a process and product (Wartono, 2003). Practical learning has also been empirically proven to increase students' active participation during learning activities. However, during this pandemic, practical activities cannot be carried out face-to-face, so it is wrong to need another alternative to facilitate students to carry out a series of practicum activities from home, namely using a virtual laboratory.

Studies on virtual laboratories have been done before. The results of previous studies, for example, are aimed at facilitating independent learning using virtual laboratories (such as PhET simulations) and learning modules independent learning/practicum modules on parabolic motion using PhET simulation "projectile motion" (Karanggulimu et al., 2017), about motion Parabola in an inclined plane without air friction (Situmeang et al., 2019), about light refraction using PhET simulation "Bending light" (Ariyani et al., 2020), about parabolic motion in a flat plane by taking air friction into account (Laga et al., 2019), and on Parabolic Motion on an inclined plane with air friction (Shaddai et al., 2019). The results of these studies are that practicum modules with these topics are effective in helping students understand the material. So, it can be concluded that PhET simulation is effectively used in physics learning.

Other research on developing PhET-assisted inquiry learning to train students' science process skills has also become a popular topic for researchers in physics education. The study's results stated that learning devices using electric KIT in PhET were mainly for dynamic electrical materials that were developed, valid, practical, and effective to train students' science process skills (Saputra, Nur, & Purnomo, 2017). In addition, there is also research on the effect of the inquiry learning model on reducing misconceptions in class X dynamic electricity material. The results of this study are that the inquiry learning model can significantly reduce students' misconceptions about dynamic electricity material (Hidayatullah et al., 2015).

Besides PhET simulation, there is Crocodile Physics which can also be used to do practical work in a virtual laboratory. Crocodile Physics is software for designing physics simulations, such as electrical simulations, dynamics, kinematics, optics, and waves (Budi, Edhi, & Sukisno, 2014). In contrast to PhET simulation, Crocodile Physics tends to be more attractive because it makes it easier for users to design experiments according to their wishes. The features provided, such as practicum equipment, have a very high resemblance and reality to actual experiments. This difference in features is also the main attraction for researchers to use Crocodile Physics simulations in physics learning, including implementing the Physics Edutainment learning model with the help of Crocodile Physics media in physics subjects. The study's results stated that learning Physics Edutainment with Crocodile Physics simulation media can improve student learning outcomes, and the results obtained are better than learning Physics Edutainment with lectures (Budi et al., 2014). In addition, other research to improve dynamic electricity learning outcomes uses the Team Assisted Individualization (TAI) learning strategy through Crocodile Physics simulation, which states that the TAI type cooperative learning strategy through Crocodile Physics simulation can improve dynamic electricity learning outcomes (Gumrowi, 2016). On the other hand, research on the use of Crocodile Physics 6.0.5 software in physics learning material in uniform, straight motion (GLBB), which states that students' learning outcomes become better, can be seen from the average score of cognitive, affective, and psychomotor aspects, respectively 85.6, 86.9, and 86.7 as well as an increase in mastery of these materials (Kereh et al., 2020).

Unlike PhET and Crocodile Physics which are already quite famous for physics education researchers, another medium that is still not very popular but is very supportive of learning activities with the concept of e-learning is Golabz. Golabz is an online science laboratory application for inquiry-based learning that aims to support the implementation of the IBSE (Inquiry-Based Science Education) approach by creating a pedagogy and technical framework that provides teachers and students with access to online science laboratories (Dikke et al., 2014). Golabz is designed for inquiry-based learning. Inquiry-based learning consists of 5 general phases and seven sub-phases (Pedaste et al., 2015). This application can also overcome problems in implementing the practice, such as the availability of time and material tools. Using Golabz, teachers can design lessons and use virtual laboratories according to their lesson plans. Golabz also provides facilities for direct interaction between educators and students. This application also allows educators to see students' progress in the teacher has designed activities.

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Before online learning became the primary choice in this pandemic era, in physics learning, simulations were used on abstract or invisible physics material to visualize physical quantities so students could better understand the material. One of the physics materials that are abstract because the physical quantities are invisible to the eye is a series RLC circuit in which there is a resonance phenomenon. The material regarding this RLC series is quite challenging to understand, so a practicum is needed to make it easier for students to understand the concept. Facts in the field show that many students still do not understand the material of alternating current circuits. The difficulties experienced by students are in mathematical calculations, graphing, and phasor diagrams (Firdaus & Muchlas, 2015). The percentage of mastery of concepts in the current and voltage sub-topics is categorized as poor, with the percentage of mastery reaching 50%, the mastery of the concept of RLC series circuits that students have is quite good, reaching 73%, while the mastery of concepts in the power sub-topic of RLC circuits is in the poor category, reaching 56% (Çıbık, 2017).

Based on the situations above, this research will be designed through physics learning about RLC circuits using Golabz, which integrates the virtual laboratory of Crocodile Physics for online learning for students. This study aims to design an online physics lesson on RLC circuits using Golabz and investigate the effectiveness of the design on students' understanding. This research helps provide an alternative to online physics learning by using a virtual laboratory.

METHOD

Research Procedure and Design

The research method used in this research is development research with the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) with stages, as shown in Figure 1.

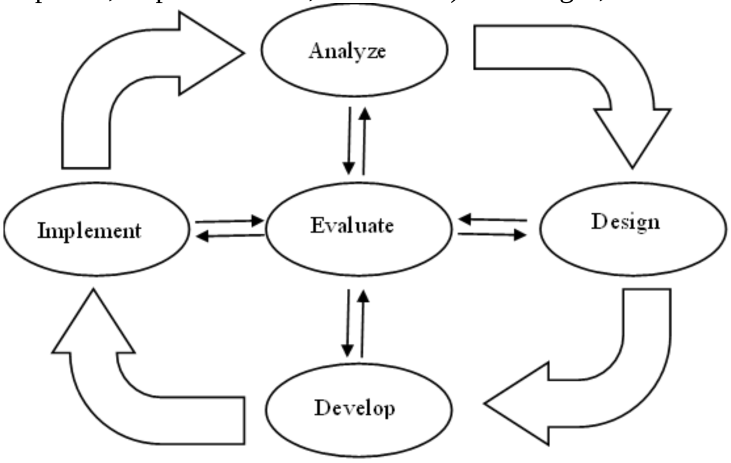

Figure 1. ADDIE Model (Dick & Carey, 1996)

1. Analysis

At this stage, three analyzes were carried out, namely needs analysis, curriculum analysis, and analysis of student characteristics through questionnaires distributed to teachers and students. A needs analysis was conducted to analyze students' needs and difficulties in learning the RLC series. Curriculum analysis is carried out to identify the achievement of learning physics in electronics courses about series RLC circuits. Analysis of student characteristics was carried out to see the condition of students while learning the series RLC series.

2. Design

From the analysis results in the previous stage, the online physics learning design based on an inquiry about the series RLC series with Golabz for the undergraduate student level was made based on the learning objectives. From the learning objectives, it can be determined that many activities will be made. Each activity is organized into five stages: orientation, conceptualization, investigation, discussion, and conclusion (O-C-I-D-C). This phase starts from the orientation stage, which is a process to stimulate students' curiosity about a topic: conceptualization, namely the process of asking questions and hypotheses. The investigation is the process of planning, experimenting, collecting, and analyzing

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data. Discussion is the process of presenting findings by discussing with other people; conclusion, namely the process of concluding the data.

Other instruments, such as material validation sheets, media validation sheets, evaluation questions, observation sheets, and questionnaires, were also prepared at the design stage. The material and media validation sheet assesses the feasibility of this learning material and media. Evaluation questions are used to measure students' level of understanding, while observation sheets record the course of learning, and questionnaires are used to determine the responses of respondents (students) who use this learning media.

Material validation includes aspects of the curriculum, material presentation, evaluation, and language. In the curriculum aspect, the things that are validated include the suitability of the learning objectives with learning outcomes, the clarity of the formulation of learning objectives, and the correctness of the material concepts in scientific aspects. In the aspect of presenting the material, the things that are validated include the suitability of the concepts described with the concepts put forward by physicists, the organization of learning materials, the suitability of the material with students' cognitive development, and the relevance of the material in everyday life. In the evaluation stage, the validation includes the suitability of the subjects and learning objectives, concepts presented, the level of difficulty of the questions, and the variation of questions. In the language aspect, the things that are validated include the use of communicative language, the accuracy of the use of terms, the suitability of the use of language with the level of student development, and sentences that are easy to understand.

Media validation includes aspects of the feasibility of content, language, graphics, and presentation. In the aspect of content feasibility, the things that are validated include conformity with learning outcomes, conformity with student development, conformity with the needs of teaching materials, and the truth of the substance of learning materials, which helps add insight. In the linguistic aspect, validated things include ease and simplicity in reading, clarity of information conveyed, and conformity with reasonable and correct Indonesian rules. In the aspect of graphics and presentation, things that are validated include clarity of writing, conformity of format, layout, and images with media display, clarity and suitability of image illustrations, suitability of features, suitability of display design, and clarity of presentation order and completeness of the information.

On the observation sheet, every step designed on Golabz media is observed comprehensively. The critical aspect observed is the level of understanding of the respondents about the media and the teacher's ability to implement the media. In contrast to other validation instruments, the assessment of the observation sheet is carried out for three types of observation sheets. This number is adjusted to the number of meetings at the learning time. An example of the activity observation sheet can be seen in Table 1.

Table 1. Observation Sheet

No	Activity
	Orientation
1	Students can write opinions about the magnitude of the inductor current and voltage in the Series RL circuit
	Conceptualization
2	Students can analyze the concepts used in practical activities by answering the questions presented
	Investigation
3	Students can calculate the inductor's current
4	Students can calculate the inductor voltage
5	Students can graph inductor voltage and current
	Discussion
6	Students can conclude the magnitude of the voltage and current when the inductor is varied, and the resistor is fixed
7	Students can conclude the magnitude of the voltage and current when the resistor is varied, and the inductor is fixed
	Conclusion
8	Students can write down the properties of the circuit formed

In the learning evaluation section, respondents are given questions that align with the learning objectives to determine the level of students' understanding of the topic being discussed. Furthermore,

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on the questionnaire sheet, student responses as respondents were analyzed related to enthusiasm for interactive learning using Golabz media, media contribution to students' ability to understand learning topics, clarity of typeface, font size, and images, as well as clarity of information and instructions for implementing learning using Golabz media. In addition, students were also asked to respond to the simplicity of the sentences in the Golabz media design and the clarity of the steps that would help students understand the material. Finally, student responses are expected to be able to provide information about the level of ease and ideal design for implementing Golabz media in online learning.

3. Development

The media is developed and validated regarding the materials and media created in the development stage. Furthermore, the results of expert validation are used as a reference for improving the design of the online physics learning e-module about the series RLC circuit using Golabz so that the media can be feasible to be implemented for students as respondents.

4. Implementation

The results obtained from the development stage are then implemented on students to determine the effectiveness of learning using Golabz. The respondents of this study were Physics Education students who were determined randomly. Students are introduced to Golabz first. After that, students were given a link to do three practicum activities independently. On the other hand, observers fill out observation sheets during online learning. After students finished working, they were assigned to fill out evaluation questions and questionnaires.

5. Evaluation

Evaluation occurs throughout the stages. It can be in stages, between one stage and another, and at the end of the implementation stage. Evaluation can be in the form of formative evaluation and summative evaluation. Formative evaluation is carried out at the development stage of the ADDIE process to improve the product before it is finally disseminated. The form of the formative evaluation is material validation by material experts and media validation by media experts. The material expert and media expert validation sheet score uses a Likert scale of 0-5. Then the validation results are calculated using equation (1), and the feasibility is determined based on Table 2.

$$A = \frac{p}{N} \times 100\% \quad (1)$$

Description: A is the percentage, p is the score obtained, and N is the maximum score.

Table 2. Presentation and Media Eligibility Criteria (Purwanto, 2013)

Percentage Range (%)	Criteria
86 – 100	Excellent
76 – 85	Good
60 – 75	Fair
55 – 59	Poor

Furthermore, a summative evaluation is carried out at the implementation stage. The data from observation sheets, questionnaires, and evaluation questions were obtained using equation (1). In the observation sheet and questionnaire, learning is said to be effective in helping students understand the material if all respondents positively respond to at least 70% of the statements on the observation sheet and questionnaire. In the evaluation of learning, learning is said to be effective if all respondents get a minimum score of 70 out of a maximum value of 100 (Karanggulimu et al., 2017).

All data obtained from validation sheets, observation sheets, questionnaires, and evaluation questions were analyzed descriptively. Inquiry learning-based online physics learning for the RLC series with Golabz is said to be effective if (1) the material and media validation sheet reaches the minimum 76% eligibility criteria, (2) all respondents give a positive response to at least 70% of the statements on the observation sheet; (3) all respondents gave a positive response to at least 70% of the statements in

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the questionnaire; and (4) all respondents scored a minimum of 70 out of a maximum score of 100 on the evaluation sheet.

RESULTS AND DISCUSSION

Analysis

1. Needs analysis

Based on the questionnaire distributed to educators and students, the difficulties encountered in learning the series RLC series include the large number of abstract discussions that require practicum to help explain. Educators have used methods to explain the RLC series' material: discussions, lectures, demonstrations, and practicum. However, in the implementation of the practicum, the obstacles faced include the tools' limitations and the students' difficulties in assembling the tools. During this pandemic, learning activities are carried out online. The practical method is also a problem.

2. Curriculum Analysis

Based on the curriculum used at the respondent's university, the objectives of learning series RLC circuits are that students can (1) explain the basic concepts of capacitors, inductors, and resistors for both AC and DC sources, (2) analyze AC circuits with phasors, frequencies and phase differences, (3) analyze the circuit (loop, mesh, Thevenin, Norton, etc.) with phasor, real, or imaginary models, and (4) calculate the frequency, magnitude of R, L, and C of the resonance circuit.

3. Character Analysis of Students

Based on the questionnaire distributed to students, they wanted the practicum method to be expanded in learning the RLC series material because it could help them understand abstract material. Students are also helped by practical work using virtual laboratories, especially during this pandemic. Students prefer the use of virtual laboratories during face-to-face learning compared to independent learning, and this is due to the lack of student skills in using virtual laboratories.

Design

The objectives of the independent physics learning practicum about the RLC series circuit with Golabz are 1) Calculating the inductor current and voltage in a series RL circuit; 2) Calculate the capacitor current and voltage in a series RC circuit, and 3) Calculate the resonant frequency in a series RLC circuit. For this reason, 3 ILS (Inquiry Learning Spaces) were made using Golabz with the following details:

1. Activity 1. Calculating the current (IL) and voltage (VL) of the inductor in a series RL circuit

At the orientation stage, students are assigned to observe a series of RL series images. Students are asked to provide opinions about the magnitude of the current and voltage in the inductor in a series RL circuit. The conceptualization stage contains guiding questions that must be answered with the practicum in the next stage. In the investigation stage, students must do an independent practicum. Students must calculate the current and voltage with different resistor and inductor values and fill in the table. Next, students create series and graphs for each data in the table in the Crocodile Physics application. The results of calculations and graphs are combined in one file for further upload to Golabz. In the discussion stage, students must conclude how large the current and voltage are in any condition, i.e., the resistor is changed while the inductor is fixed, and the resistor is fixed while the inductor is changed. In the conclusion stage, students are asked to write down the nature of the circuit formed.

2. Activity 2. Calculating the current (IC) and voltage (VC) of a capacitor in a series RC circuit

At the orientation stage, students are assigned to observe a series of RC pictures. Students are asked to give opinions about the magnitude of the current and voltage of the capacitor in a series RC circuit. The conceptualization stage contains guiding questions that need to be answered with the practicum in the next stage. In the investigation stage, students must do an independent practicum. Students must calculate the current and voltage with different resistor and capacitor values and fill in the table provided. Next, students make circuits and graphs according to the data in the table in the Crocodile Physics application. The results of calculations and graphs are combined in one file for further

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upload to Golabz. In the discussion stage, students must conclude the amount of current and voltage if the resistor is changed while the capacitor is fixed and also if the resistor is fixed while the capacitor is changed. In the conclusion stage, students are asked to write down the nature of the circuit formed.

3. Activity 3. Calculating the resonant frequency in a series RLC circuit

The orientation stage contains a review of the two previous activities. The conceptualization stage contains guiding questions that must be answered by practicum carried out in the next stage. In the investigation stage, students are tasked with compiling a series RLC circuit by determining the size of the resistor, inductor, capacitor, and voltage. Furthermore, students must calculate the magnitude of the resonance frequency formed and observe the resulting graph. In the discussion stage, students upload the calculation results and the resulting graph on the Crocodile Physics application. In the conclusion stage, students can conclude the nature of the circuit formed. In addition, at this stage, students must work on evaluation questions and upload them to Golabz.

Development

At this stage, material and media experts validate the media that has been designed in the previous stage. Material validation includes aspects of the curriculum, material presentation, evaluation, and language. Media validation includes aspects of content feasibility components, linguistic components, and graphic and presentation components. Furthermore, analysis and revision of the results of the validation of media and material experts were carried out. The results of the validation test can be seen in Table 3.

Table 3. Media Expert and Material Expert Validation Results

	Topics	Media
Percentages	89.30%	94.30%
Criteria	Excellent	Excellent

From Table 3, it is known that the validation results from material experts and media experts received very good predicates for the feasibility of their use. This media can be used after repairing it first. The following are some suggestions given by the validator, namely, (1) Adding material about phase differences, (2) Explanation of practical examples of the application of a series RLC circuit in electronic equipment (3) Adding a guide to make a complete circuit. (4) Addition of circuit visualization using phasor diagrams. All suggestions are accepted as material for improvement except the fourth suggestion because the visualization displayed by the Crocodile Physics application is not a phasor diagram but a sine diagram, so phasor diagrams are not needed in this study. After being revised in several parts, this learning design is ready to be implemented by students.

Implementation

The learning design was implemented for 6 Physics Education students at this stage. Each student does three activities that have been prepared. The implementation process is shown in Figure 2.

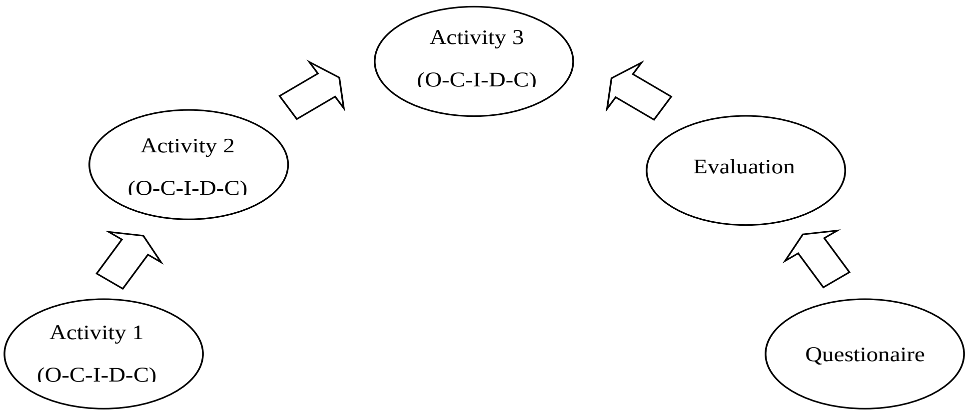

Figure 2. Learning Activity

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1. Activity 1. Calculating the current (IL) and voltage (VL) of the inductor in a series RL circuit

At the orientation stage, all students can predict the current and voltage of the inductor in a series RL circuit. They can write their opinion in the box provided. Most students answered that the current that flows is the same, but the voltage is different. The conceptualization stage only contains questions to lead students to do the practicum. In the investigation stage, most students could calculate the current and voltage for various resistor and inductor values and write them down in the table provided. All students can make circuits and graphs in the crocodile physics application, although 3 out of 6 students are still not optimal in making graphs. The students' inadequacy in making graphs has not been able to visualize a sine graph. Most of them have not set the X and Y axes.

In the discussion stage, all students could conclude the amount of current and voltage when the inductor-fixed resistor was changed and when the resistor was changed to a fixed inductor. Most of them have been able to conclude precisely and correctly, namely, when the fixed resistor and inductor are changed, the current is constant, and the voltage is more significant. Meanwhile, the current and voltage get smaller when the resistor is changed and the inductor remains large. In the conclusion stage, all students can write down the nature of the circuit formed. All students answered that the nature of the circuit formed was inductive, where the voltage preceded the current.

2. Activity 2. Calculating the current (IC) and voltage (VC) of a capacitor in a series RC circuit

At the orientation stage, all students can predict the current and voltage of the inductor in a series RC circuit. They can write their opinion in the box provided. Most of the students answered that the current that flows is the same, but the voltage of each component is different because it is a series circuit. The conceptualization stage only contains questions to lead students to do the practicum. In the investigation stage, most students were able to calculate the current and voltage for various values of resistors and capacitors and write them down in the table provided, but they were still not careful with the calculations. All students can create circuits and graphs in the Crocodile Physics application. However, 3 out of 6 students are still not maximal in making graphs. Just like the previous activity, the graph shown is still not sine shaped because the X and Y axes on the graph are not set.

In the discussion stage, all students could conclude the amount of current and voltage when a fixed resistor and a fixed capacitor were changed and when the resistor was changed to a fixed capacitor. However, only a few students answered correctly: when the fixed resistor and capacitor are changed, the value gets bigger, the current gets more prominent, and the voltage gets smaller. Meanwhile, when the resistor is changed, the greater the value and the capacitor remains significant, the current and voltage get smaller. In the conclusion stage, all students can write down the nature of the circuit formed. Most of the students answered that the nature of the circuit formed was capacitive, where the current preceded the voltage

3. Activity 3. Calculating the resonant frequency in a series RLC circuit

In this activity, the orientation and conceptualization stages contain an introduction, review, and guiding questions for conducting practicum. In the investigation stage, students can make circuits with the values of resistors, inductors, capacitors, and signal generators determined by themselves. The value chosen by each student varies greatly. Students can also calculate the resonant frequency produced by the circuit they make. All students can also make graphs of the circuits they make, although the graphs shown by Crocodile Physics are not following existing theory, where there is no phase difference between current and voltage in a resonant circuit. In Crocodile Physics, the formed graphs are capacitive, and some are inductive. Therefore, it is necessary to do further research on the manufacture of resonant frequency graphs in the application of Crocodile Physics.

In the discussion stage, all students can upload their work in the form of the results of calculations, the series made, and the graphs formed. In the conclusion stage, all students write down the nature of the circuit formed. Most answer the nature of the circuit is capacitive. This is because the graph generated in the Crocodile Physics app shows current precedes voltage. Students can work on evaluation questions consisting of 3 description questions and collect them in the place provided at this conclusion stage. While the students were working on the module, three observers observed them see the learning process that occurred. After doing these three activities and the evaluation questions, students also filled out a questionnaire sheet.

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Evaluation

1. Observation Sheet

The observer observed and filled out the online observation sheet during the learning activities. To calculate the percentage of success in learning activities, equation (1) is used. The results of the observation sheet can be seen in Table 4.

Table 4. The result of the Observation Sheets

Students	Percentages (%)		
	Activity 1	Activity 2	Activity `3
A	71.00	71.00	67.00
B	71.00	57.00	100.00
C	100.00	71.00	100.00
D	71.00	57.00	100.00
E	100.00	71.00	100.00
F	86.00	86.00	100.00

Table 3 shows that in Activity 1 all students got 70%, while in Activity 2, only 50% of students got 70%. This is due to the students' inaccuracy in calculating the capacitor current and voltage. In Activity 3, all students got 70%. All students succeeded in doing learning activities with an average of 82%. This means that the learning design using Golabz is effectively used by students.

2. Questionnaire Sheet

Questionnaires were given to students to see their responses to the online physics learning design using Golabz. The questionnaire was distributed in a google form with seven questions. The questions given include enthusiasm, clarity of Golabz media, and ease of understanding the material. The percentage of the questionnaire is calculated using equation (1). The results of the questionnaire can be seen in Table 5.

Table 5. Questionnaire Results

Students	Percentages (%)
A	100.00
B	100.00
C	100.00
D	86.00
E	100.00
F	100.00

Based on Table 5, all students gave 70% positive responses to all questionnaire statements, with an average of 98%. Most students expressed enthusiasm for participating in interactive learning using Golabz media. All students stated that Golabz media helped students understand the material. The typeface, font size, pictures, and the use of sentences in Golabz are also easy to understand. Golabz designs provide clear information and instructions that help understand the material provided. All students also responded positively if learning through Golabz was applied to online learning as it is today. From the questionnaire results, it can be concluded that the learning design using Golabz effectively can be applied.

3. Evaluation Sheet

Students work on evaluation questions online through Golabz to measure their understanding of series RLC circuits. The results of the evaluation can be seen in Table 6.

Table 6. Evaluation result

Students	Percentages (%)
A	56.25
B	93.75
C	37.50
D	100.00

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Students	Percentages (%)
E	62.50
F	81.25

From the evaluation results, it is known that 3 out of 6 students scored less than 70 out of a maximum score of 100. This happened because of the students' inaccuracy in calculations and the lack of understanding of the impedance material, so the question about impedance was not answered. According to the respondents, the questions were straightforward, but they still did not understand how to do them. The average evaluation results obtained were 71.88%. From these results, the learning design is enough to help students understand the material but can be developed again for better results.

CONCLUSION

Based on the results of the research above, the following results were obtained (1) The results of learning observations showed that all respondents could follow the learning well with an average of 82.00%. (2) All respondents responded positively to a minimum of 70.00% of the questionnaire statements, with an average of 98.00%. (3) Some students can obtain evaluation results of more than 70.00%, with an average of 71.88%. Thus, all indicators of success are achieved, and the online physics learning design about serial RLC circuits using Golabz is said to be practical and helpful for students to understand the material of serial RLC circuits. So this learning design can be used as an alternative to online learning during the Covid-19 pandemic that provides inquiry-based learning, provides independent practicum, can be accessed online anytime and anywhere, and is an interactive media. For further research, there is still potential for developing the Golabz integrated Crocodile Physics application to search for resonant frequencies; further improvements are needed for understanding the material.

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