Effectiveness of visual programming implementation in thermodynamic experiments with the ISLE-based STEM approach model

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Abstract. Visual programming utilizes visual presentation to describe programs, data, structures, or dynamic behavior of complex systems. Labview is a visual programming software made by national instruments using language based on graphics or block diagrams. Labview is applied to thermodynamic experiments to see the effectiveness of the implementation in students learning through the ISLE-based STEM approach. Experiments by the students were finding the specific heating value and discovering the concept of the Black principle by utilizing the Dallas 18B20 as a temperature sensor that is connected through the NodeMCU ESP8266 device and Labview software. This research was conducted at SMA LabSchool Unsyiah with a total of 10 students participated following the pandemic protocol procedure. The data analysis results showed that 85% of students were happy with the learning approach, 80% of students were interested in the teaching materials, 78% of students stated that the experiments were effective for learning the concepts, 90% of students stated that they developed thinking skills. Students get an increase in scores on the post-test as much as 89% from the results of the pre-test. The assessment of the implementation of learning by the observer obtained a mean of 80.5%.

1. Introduction

Investigative Science Learning Environment (ISLE), is a learning model for investigative science learning environment [1]. ISLE helps students learn physics by engaging in processes that reflect the activity of physicists as they build and apply knowledge. This process involves observing, finding patterns, constructing and testing pattern plans, and using multiple representations of physical phenomena [2]. Visual programming has become a trend at an early age where many benefits can be taken, one of which is visual programming that can be used easily by anyone without having to learn programming code, besides that visual programming can also shorten the time needed to create a system where programming code is generated from the design. Visually is 'computer generated' thereby reducing the possibility of errors. Visual programming uses visualization where there are visual representations of graphics, images and animations. Some of the visual programming commonly used are: microsoft visual studio, microsoft visual basic, scatch, ardublock, mBlock, miniblog and labview. Labview is a programming software made by national instruments using a graphical or block diagram based programming language, Labview has the same functions and roles as
other programming languages such as C++, Matlab or visual basic. Programming made with Labview is also called a virtual instrument or Vis because its work, appearance and operation are similar to a physical instrument[3].

The advantages of discussing programming using Labview include: easy to debug or detect errors, easy to follow the flow of VI, easy to create simulations that display a Graphical User Interface, programming is made hierarchically and modular, meaning that each VI can be used as a subVI of another VI, if we want to make an application that is quite complicated, then we can divide it into several modules and then you can divide it into several submodules that are simpler. The application of visual programming in physics subjects with the topic of the Black principle begins with the ability of students to analyze the physical quantities found in hot water and cold water, then students are asked to measure the temperature with a temperature measuring device that is designed and connected to the labview, students are asked to make programming that will used to display the temperature value in Labview using a technology guide. This method is able to increase student interest in learning and understanding of the lessons presented, students are able to think critically, creatively and collaborate in solving problems. Students are given a technology guide as a reference that can be used in the program making process[4].

2. Methodology
This research was conducted to see the effectiveness of learning using visual programming with a pleasant learning atmosphere. The approach used is descriptive quantitative approach. The sample in this study were 10 students of class VI SMA Labschool Unsyiah. This research stage goes through the process of literature study, product design, product manufacture, product feasibility test, implementation and evaluation. The data processing technique used in this study was to analyze expert validation data, student responses to lessons and student learning outcomes. The researchers designed the props for the topic of temperature and heat which can be used for specific heat practicum, the energy needed to heat water, and the Black Principle. The design of the props starts with system design, schematic design of circuits, heating of electronic components, designing the Labview display through visual programming, designing the Labview communication system with props through programming in the Arduino application using the C language. This tool is used to measure temperature and voltage, connected with NodeMCU 8266 which can communicate with a computer to be displayed on the LabVIEW front panel via a WiFi network, the props and the computer user must be connected to the same wifi network, this tool uses IP addresses to recognize each other, but uses UDP transport so that Data sent can be performed continuously by NodeMCU without requiring confirmation from the computer. This tool adopts current from a power bank, to be able to operate, able to measure the electric voltage from the electric heating terminal used, by measuring the voltage between resistance 1 (100k ohms) and 2 (10 k ohm) which is connected to the A0 NodeMCU leg the heater sensor is connected to the A0 NodeMCU leg. Labview is used as an interface device, which will display the results of the measurements from the props. In the Labview block diagram, visual programming can be made and add several parameters that can help students understanding. The following is the design of thermodynamic props.

The measurement results of dallas 18B20 will be read by the microcontroller and transferred to the desktop for visualization and analysis. Data transfer from a microcontroller to a desktop or laptop can use a USB data cable or via wifi (wireless) by utilizing a microcontroller equipped with IoT (Internet of Think) in this study using NodeMCU ESP8266. Measurement results data that are transferred to the desktop need to be visualized so that they are attractive to students and at the same time can be analyzed by students’ measurement results. System software design begins with identifying how to display data sent from props to the computer and displayed in graphical form with the help of LabVIEW. Then introduced a simple template for how LabVIEW can receive data in the UDP protocol[6], the stages are generally stated as follows:

\[
\text{strings \rightarrow splitting string \rightarrow conversion to numeric \rightarrow plotting of numeric time series}
\]
This stage is implemented using block diagrams to facilitate students' understanding of the workflow of the program being made, the program creation process is carried out by selecting the block diagrams needed to have a control palette or a function palette and connecting them using a wire. Figure 2 shows one of the block diagrams.

The data collection technique used to assess the success or failure of the ISLE-based STEM approach, especially the topic of temperature and heat, was carried out in three ways, namely: using a questionnaire, interview, and observer [7].

**Questionnaire**

The questionnaire is a technique of data collection using a questionnaire sheet. The questionnaire in this study was used to determine the evaluation of the level of interest of students and teachers/observers in learning using the ISLE-based STEM approach. The questionnaire in this study is closed because answers have been provided. Researchers used a questionnaire because this instrument can be used with a large number of respondents and scattered. Questionnaires are given by direct contact with respondents so that it is hoped that the data provided can be objective and in a fast manner. This technique aims to measure the feasibility of a product in terms of various aspects, including:

a) Validation Sheet

The validation sheet is used to determine the feasibility of the developed product which is assessed by experts and subject teachers during the validation process.

b) Student Response Sheet

This sheet is used to measure student attractiveness and interest (student responses) to the use of the product being developed.
c) Learning Implementation Observation Sheet

During the implementation of product trials in the learning process, data on the implementation of learning using props/teaching aids and ISLE-Based STEM LKPD were obtained for experiments on temperature and heat topics. Observation of the implementation of this learning can be done by fellow researchers and teachers in the field of study [8].

3. Result and discussion

3.1. Data analysis

Performance and evaluation of props need to be tested by calculating the error value analysis carried out by comparing the difference between the limited error value against the actual set value. The following is the formula for finding the presentation of errors that occur in sensors

\[
\text{\% Error} = \frac{\text{real value} - \text{the measured value}}{\text{real value}} \times 100\%
\]

In the next stage, the researcher validates the media and material presented on the props and student worksheet. The validator is an expert lecturer and a physics teacher. Validation is carried out to determine the feasibility value of the product that has been developed. The validator assesses and provides input through filling out the validation sheet using five rating scales, namely: (5) very good, (4) good, (3) sufficient, (2) not good, (1) not good. Instruments that have been validated by the validator are then analyzed using the following equation [9]:

\[
\text{Percentage} (%) = \frac{A}{B} \times 100\%
\]

Information:  
A = Score data collection result;  
B = Ideal scrol.

The percentage results obtained was then converted into a qualitative scale based on the categories which can be seen in table 1.

| Interval Skor | Kriteria       |
|--------------|---------------|
| 76% ≤ P ≤ 100% | Very good    |
| 51% ≤ P ≤ 75%  | Good          |
| 26% ≤ P ≤ 50%  | Sufficient    |
| 0% ≤ P ≤ 25%   | Not good      |

3.2. Props produced

The following is the physical form of the props produced

![Figure 3: Props produced.](image-url)
The display of Labview is designed in such a way as to make reading easy for students. The following is a front panel display of temperature and heat props specifically on the topic of electrical energy for heating water.

Figure 4: Labview display. Expert Validity Analysis Data.

The table below shows the results of the LKPD temperature and heat assessment by material experts. The percentage of validation results by material experts on aspects of relevance to teaching materials is 90%, aspects of educational value are 85%, efficiency is 80%, content feasibility is 93%, presentation feasibility is 87%, language eligibility is 75%, ISLE aspects are 90% and the Communicative aspect by 73% and the STEM aspect by 90%.

Figure 5: Result of validations expert on LKPD instruments.

Based on the analysis of media experts, the results of the analysis of the props get a mean score of 4.01 with a mean value of 80.3% in the very good category.

Figure 6: Material expert analysis.
Then the material expert data analysis obtained an average score of 3.35 with an average percentage value of 83.8% in the very good category.

3.2. Student Assessment Analysis
The percentage of student validation results on the limited test, the relationship between fun aspects to using is 85%, the relationship with teaching materials is 80%, the conceptual suitability is 80%, the tool efficiency is 85%, related to technology is 85%, language feasibility is 80%, developing thinking ability 90%, STEM by 80%, ISLE by 83%, developing skill skills by 91% and technological literacy by 80% and understanding concepts by 90%.

![Figure 7: Result of student responses to props.](image1)

![Figure 8: Result of student responses to the learning process.](image2)

3.3. Lesson Study Implementation Analysis
Learning media developed through the ISLE Based STEM model after going through a limited trial phase which was then validated by material experts and media experts, then implementing the implementation of learning through lesson study. The data on the results of the implementation of the Lesson Study was obtained based on the evaluation and assessment carried out by the Observer Teacher on the observation sheets provided. The following is a table of data on the results of the Lesson Study implementation.

![Figure 9: lesson study Implementation analysis.](image3)
From the data obtained above, the percentage of validation results by observer teachers on the PLAN aspect was 92%, the DO aspect was 76%, the SEE aspect was 82%, the 2013 Curriculum Aspect (K.13) was 89% and the ISLE aspect was 78% and the STEM aspect was 75%.

4. Conclusion
The improving ISLE-based STEM learning media can increase students' understanding in learning the concepts of temperature and heat, this is indicated by the results of the pretest and posttest which increased significantly. The results of student responses to the use of APP are 83% and LKPD are 84.5% and fall into the very good category.

5. Acknowledgments
The authors would like to acknowledge the undergraduate and master students focusing on Physics Teaching in Universitas Syiah Kuala who participated in this study. This research was supported financially by the research project Implementation Assignment Category A STEM Research Center Number 291/UN11/SPK/PNBP/2020. The LabVIEW software we used in the study came from NAS and USAID support under USAID Prime Award Number AID-OAA-A-11-00012.

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