Developing labview-based experimental simulation application on teaching materials of gas kinetic theory in senior high school

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Abstract. Experiments on the teaching materials of Gas Kinetic Theory in Senior High School have not been implemented because of the difficulty of carrying out such experiments in real laboratories. It encourages researchers to develop a LabView-based experimental simulation application on gas kinetic theory materials in Senior High Scholl. This research aims to produce a valid LabView-based experimental simulation application on gas kinetic theory materials in Senior High Scholl. The type of this research is Research and Development (R & D). This research consists of three phases namely define, design, and development. The instrument of this research was the validation sheet. The prototype of a LabView-based experimental simulation application on gas kinetic theory materials in Senior High Scholl was validated by 2 validators. The result of validation describes that the LabView-based experimental simulation application on gas kinetic theory materials in Senior High Scholl was highly valid.

1. Introduction

According to Suparno on [1], physics is considered important to be taught as a subject, because it can build thinking an ability to solve problems in everyday life and equip learners with knowledge, comprehension and a number of capabilities as a condition to enter a higher education. In addition, physics is a physical knowledge, then, to study physics and to form the knowledge of physics, it takes direct contact with the wanted things, because physics is a science that requires more understanding than memorization. Therefore, in studying physics, it is very important to involve students in finding a concept. Then the students do not just accept the concept from the teacher only. This is in line with the principles of the 2013 curriculum that change the paradigm of learning to be student-centered.

In physics learning, the process of finding a concept or fact can be done through experimental or practical works. This is also in line with the syllabus of the subject in the 2013 curriculum [2], which requires practical work. However, in physics learning not all materials can be done experimentally in the laboratory, then the material is often considered abstract by the students. Based on preliminary research in a senior high school in Payakumbuh, it was obtained that one material that was considered abstract by high school students was the material of gas kinetic theory. It is because there were no
experiments that can be done in the laboratory when the material was learned. Based on interviews with physics teachers, the researchers also obtained information that experiments could not be done due to the lack of experimental tools on the material of gas kinetic theory in the school. Because of that, the teachers only explained the concepts through lecture method. According to the teachers, experiments on the material of gas kinetic theory are also difficult to do in real laboratories.

Experiments that are difficult to execute in a real laboratory due to the lack of experimental tools, can be overcome by using Computer-Based Laboratory (CBL) method. Through the method, experiments can be done virtually by giving certain assumptions on the state when the experiment is done and then students can manipulate the data, analyze the data, and finally draw conclusions [3].

Computer-Based Laboratory can be developed using a variety of computer software applications. For example, Phet Interactive Simulations, which is developed by Colorado University, contains a simulation of physics, chemistry, and biology learning that is given for free by the University of Colorado [4]. In the Phet simulation, there are experimental simulations on the kinetic gas theory material that explain experiments on gas molecules which are affected by macroscopic quantities such as volume, temperature, and pressure, as well as an energy histogram.

However, this Phet simulation is not accommodated yet to store data that have been input by the user. Therefore, users can not analyze their virtual experiment activities after resetting the simulation program. Phet simulation also has no P-V and T-V graphical display. Besides that, the simulation manual is also not instructional, because of that, students' worksheet is required if the teachers want to use it in the classroom [5].

Computer-based physics laboratories can also be developed by using LabVIEW (Laboratory Virtual Instrument Engineering Workbench) program. LabVIEW is a programming software that uses Graphical Language, a programming language that uses an icon template to give command line which is executed by a computer. [6] have developed a simulation of physics experiments on radioactive materials using LabVIEW and got a valid result.

Developing a LabVIEW-based experimental simulation on the kinetic gas theory material in accordance with the 2013 curriculum should be done. It is based on a previous research by [7] and [8] on the application of virtual laboratories to improve learning outcomes. Therefore, it is hoped that developing LabView-based experimental simulation on kinetic gas theory materials will produce a valid product and can be used in physics learning in schools.

2. Methodology
This study used to research and development (R & D) method. According to Thiagarajan in [9], the steps of research and development can be done by the 4-D method, which consists of Define, Design, Development, and Dissemination. This paper is until the development stage.

2.1. Define
At this stage, need analysis was done. A concept analysis was conducted to analyze the concepts to be simulated in the experiment and to plan the steps to be undertaken. To analyze it, the researchers did: 1) Syllabus analysis and 2) Physics learning media analysis that has been used by physics teachers in explaining the gas kinetic theory.

2.2. Design
This stage was conducted to design and prepare the prototype of LabVIEW-based experimental simulations on kinetic gas theory material. According to [10], developing a simulation model media can be done on the following stages; a) Creating a program design of simulation model by analyzing the curriculum and competence to generate a unit of learning to be put into the outline of media programs (GBPM). b) Constructing a program flowchart. The flowchart is a flow of experimental physics simulation program that consists of a start, content and exit program. c) Programming by using computer device as main equipment by involving LabVIEW software in designing its simulation...
program. This activity ended with the production of a Labview-based experimental simulation prototype on the kinetic gas theory material.

2.3. Development
The development stage was carried out after the prototype was complete. At this stage, the validity of the product was validated by experts, media/computation expert and the lecturers of the General Physics subject. The suggestions provided by the validators were used to improve the product.

3. Result and Discussion

3.1. Result
The final product of this research is a LabVIEW-based experimental simulation application on kinetic gas theory material. This application is in an installer form that can be played on a PC or laptop. The Initial display of the Simulation Experimental front Panel like as Figure 1.

Figure 1. The initial display of the LabVIEW-based experimental simulation application front Panel

Furthermore, if the user clicks the "Detail" button, it will show detail instructions about the use of this experimental physics simulation media like as Figure 2. Usage instructions are also displayed on the front panel.
Figure 2. The display of the LabVIEW Based Experimental Simulation Application Usage

Furthermore, if the user follows the instructions then the next step that must be done to perform the experiment through the simulation application is to click the "display control input". The simulation media will show the initial conditions of the experiment. Users can choose an experiment to do first by selecting the process on the "Select Process" button. Then please specify initial pressure, volume and initial temperature. The next step, the user can click the "display final condition". Then the display will appear as in Figure 3.

Figure 3. Final Condition Display in LabVIEW - Based Experimental Simulation Application
Then the user can click the "display calculation". The display will appear as in Figure 4.

![Figure 4](image4.png)

**Figure 4.** The Display Calculations on LabVIEW-based Experimental Simulation Application

Next, to view the animation on this simulation media, a user must click "animated display" button. The display will appear as in Figure 5.

![Figure 5](image5.png)

**Figure 5.** Animation display on LabVIEW-based Experimental Simulation Application

Furthermore, the user can see the graph relation between pressure and volume (P-V) and graph relation pressure with temperature (P-T) like as Figure 6.
Figure 6. Graph Display of P-V and P-T on LabVIEW-Based Experimental Simulation Application

Next, the user can see the observation data in the observation table that has been provided by clicking the button "display observation table and Notes To Readers". Observational data performed on LabVIEW-based experimental simulation applications can be stored and exported into excel files. The display of observation table like as Figure 7.

Figure 7.a. The Display of Observation Data Table on LabVIEW-Based Experimental Simulation Application
3.2. Validation of LabVIEW-based Experimental Simulation Application

Once the LabVIEW-based experimental simulation application has been completed, a validation phase was performed. Validation was done by two validators using the validation sheet as the instrument. Comments from the validators were taken into consideration for the improvement of experimental simulation application that has been designed in order to produce a valid Labview-based experimental simulation application.

**Table 1.** The Results of validation LabVIEW - Based Experimental Simulation on Kinetic Gas Theory material

| NO | The validation aspects                      | Validator 1 | Validator 2 | Max score | Score (%) | Category        |
|----|--------------------------------------------|-------------|-------------|-----------|-----------|-----------------|
| 1  | Quality of Content and Purpose             | 3.5         | 4           | 8         | 93.75     | highly Valid    |
| 2  | Instructional Quality                       | 3           | 3.4         | 8         | 80        | Valid           |
| 3  | Technical Quality                           | 3.2         | 4           | 8         | 90        | highly Valid    |

**Totally score**

| 87.92 |

Table 1 shows that the average validation score of LabVIEW based experimental application simulation on the material of gas kinetic theory was 87.92%. According to the criteria of assessment by the experts [11], it was obtained that the LabVIEW-based experimental simulation application on kinetic gas theory material was highly valid. It can be concluded that the product of the simulation application can be used for testing in the next research.
3.3. Discussion
The LabVIEW-based experimental simulation application has been highly valid based on the result of the validator's assessment for the following reasons. The quality aspect of content and objectives was valid from the scope of the content of the experimental simulation application in accordance with the applicable high school / MA physical curriculum. The LabVIEW-based experimental simulation application consists of five experimental activities on the kinetic gas theory material, which is in constant volume state, constant pressure, constant temperature, adiabatic and polytropic process equipped with pressure graph display (P) with temperature (T) and pressure graph (P) with volume (V). Observation data by students in the simulation application can be stored in an excel file so that whenever learners want to analyze the data can be done. According to the experimental simulation experiments that the researchers produce can give an idea of the concept of kinetic theory of gas in students. In addition, a LabVIEW-based experimental simulation application can be an alternative for teachers to overcome the scarcity of practicum tools. This is in accordance with the opinion of [12] that the simulation method by using virtual laboratory is one of the effective methods in applying the 2013 curriculum which is also in accordance with the characteristics of current learners who like things related to computer. Validator also argues that the concept of gas kinetic theory in this simulation is fitting applied and is a good solution because the practicum is often constrained to be implemented due to the fire and to the safety factor of the students at the lab.

The valid instructional quality aspect seen from the application usage guides at the beginning of the application is opened by the students in great detail. Learners can follow each step in the instruction manual. So, the LabVIEW-based experimental simulation application can help the teacher in explaining material that is difficult to do the experiment in the real laboratory.

Technical quality aspect is very valid seen from the simulation application of experiments easy to use by learners with a display on the front panel that raises the attractiveness of both shape and color. In addition, the use of text, graphics, and animation in LabVIEW based experimental simulation applications is proportional.

4. Conclusion
This research has produced an experimental application based on LabVIEW on teaching material of gas kinetic theory in senior high school. The result of LabVIEW-based experimental simulation application on gas kinetic theory material validity was highly valid with validation value 87.92%.

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