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RESEARCH ARTICLE

Design of Arduino Uno-based laboratory glove box with UV lamp, blower, and DHT22 sensor for learning media

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ABSTRACT

A laboratory glove box is a customized instrument that allows users to manipulate things in a controlled environment. It creates a different atmosphere within a chamber and can also be used as a sterilizer. The project named Design and Build a Laboratory Glove Box Using UV Lamps and Blower Equipped with a DHT 22 Sensor Based on Arduino Uno for Learning Media' seeks to improve the quality of student learning. Using this glove box, students can gain a better understanding of fundamental ideas, operational methods, and standard operating protocols for laboratory glove box equipment. The feasibility tests, including validation by media experts and material experts, indicate that ' 'Design and Build a Laboratory Glove Box Using UV Lamps and Blower Equipped with a DHT 22 Sensor Based on Arduino Uno for Learning Media' is highly suitable for practical use.

KEYWORDS

Glove box; sterilizer; learning Media

CITATION

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1. Introduction

The learning process, particularly for students, plays a pivotal role. The concept imparted in trainer learning entails more than merely conveying theories and interface concepts through illustrative representations on paper. For students who find the concept of trainer learning challenging, this learning concept aims to facilitate comprehension of the material and concept of tools during practicum learning (Dzaiy & Abdullah, 2024). A laboratory glove box is a device designed to allow a person to manipulate objects or objects in a separate atmosphere in a chamber and as a sterilizing device. The box is typically transparent in part or in its

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entirety, enabling the user to observe the object being manipulated and sterilized (Kusumah & Pradana, 2019).

Learning basic laboratory equipment is essentially an educational process that aims to create conditions for students to master concepts, principles, and skills as well as curiosity about laboratories in order to improve the quality of science and technology (Mohzana et al., 2023). Glove box systems have not yet become a prevalent component of scientific laboratory environments, despite their critical function in safeguarding laboratory personnel during sterilization procedure (Al Bari et al., 2023). The glove box system plays a pivotal role in protecting laboratory personnel from hazardous materials during the sterilization process. By applying the concept of interactive learning to the laboratory Glove box tool, it is hoped that electromedical students can easily understand the basic concepts, workings and troubleshooting (Krishnakanth et al., 2022). In fact, the laboratory Glove box tool in circulation is still very expensive for private college classes. It is hoped that the development of this learning media will facilitate students in the learning process of basic laboratory equipment.

Implementing interactive learning by using this laboratory glove box tool is expected to improve the quality of learning for students and easily understand the basic concepts, workings and Standard Operating Procedures (SOP) of the laboratory glove box tool. The laboratory glove box learning media designed uses a portable blower with a UV lamp and is equipped with a DHT22 sensor to monitor temperature and humidity parameters. The microcontroller used for the design of this laboratory glove box learning media is the ATMega328-based Arduino Uno Microcontroller.

2. Literature review

2.1. Laboratory glove box

Laboratory glove box is an important part of a laboratory as a sterilization tool. A tool designed to allow a person to manipulate objects in a separate atmosphere, part or all of the box is usually transparent so that users can see what is being manipulated and sterilized (Cahyani et al., 2024). The Glove Box tool can be seen in Figure 1.

Figure 1. Laboratory glove box. Source: https://www.cleaverscientific.com

Figure 2. Ultraviolet (UV) light. Source: (Fitriyah et al., 2022)

2.2. UV sterilization

Sterilization is generally carried out on objects related to the medical world. Sterilization using ultraviolet light is commonly used for room sterilization (Jildeh et al., 2021). Ultraviolet radiation can kill bacteria with wavelengths between 220-290 nm and the most effective radiation length is 253.7 nm (Rahmi & Yelfianhar, 2023). Radiation is categorized as UVA (315-400nm), UVB (280-315), and UVC (100-280nm) (MOH, 2022). Ultraviolet (UV) light is shown in Figure 2. Exposure of skin cells to high levels of UV radiation has harmful health effects. In the short term, intense exposure of pale skin to UVB rays causes inflammation or sunburn and local immunosuppression. Long-term UV exposure to deeper skin over many years causes skin wrinkles and premature aging of the skin, and leads to skin cancers such as basal cell cancer, squamous cell cancer, and malignant melanoma (MOH, The Importance of Protecting Skin from Ultraviolet Light, 2022).

3. Methods

3.1. Design hardware & software

The research and development method is a research method used to produce certain products and test their effectiveness (Hariyono et al., 2023). Meanwhile, Sukmadinata (2008) states that research and development is a research approach that aims to create new products or improve existing products (Sa'diyah et al., 2020).

The resulting product can be in the form of software or hardware, such as books, modules, packages, learning programs, or learning aids. Figure ***3*** depicts the design of the tool block diagram. The block diagram is a component of the system's principle or performance when creating a tool design; typically, the block diagram is arranged at a high angle of view and does not overemphasize the system's detailed components (Rahmanto et al., 2021).

Design is a planning or design that is carried out before the manufacture of an object, system, component, or structure (Itsnaini, 2021). Figure ***4*** shows the tool design model.

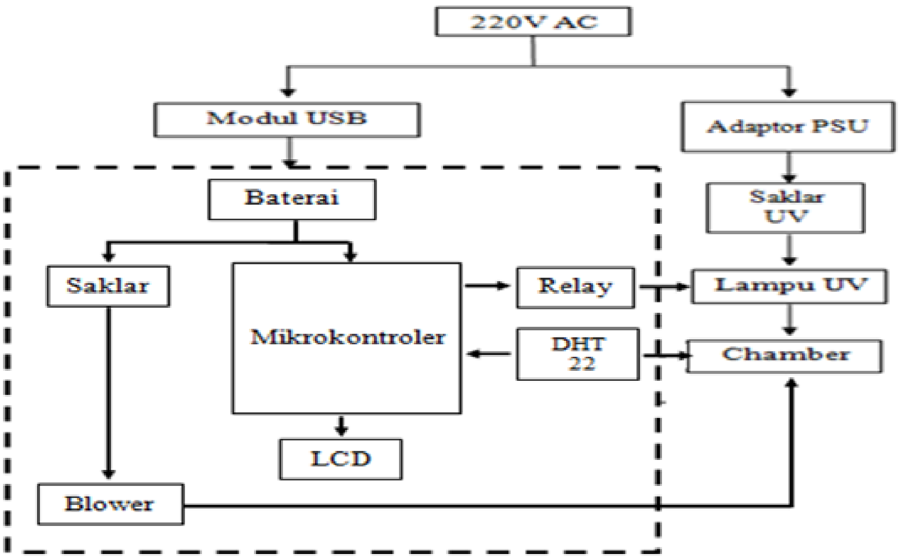

Figure 3. The block diagram

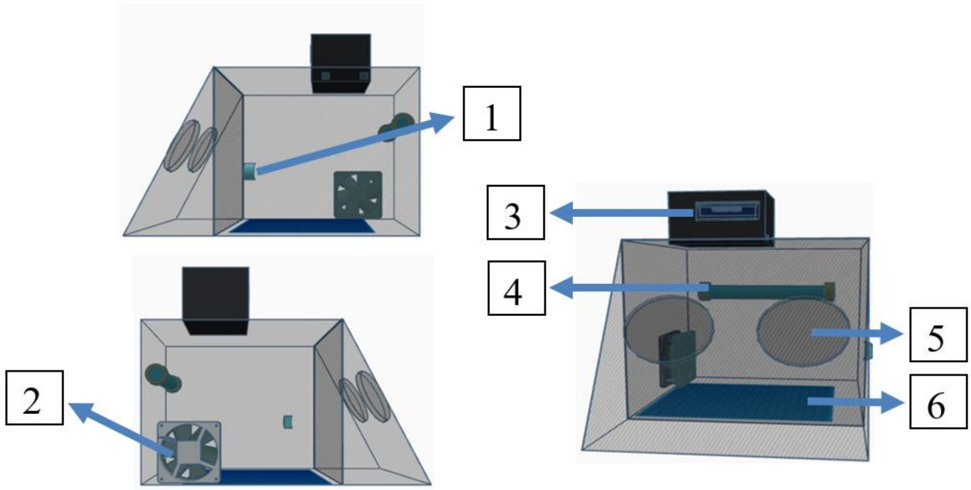

Figure 4. Design model

The explanation of some parts of the tool is as follows:

1. Door

   Serves for the path to enter the tool or object to be sterilized in the chamber.

2. Blower

   Serves to increase the air pressure in the chamber.

3. Liquid crystal display (LCD)

   Serves to display the results of sensor readings

4. Ultraviolet Lamp
   Serves as a sterilizer for tools or objects in the chamber.
5. Glove hole
   Serves to protect hands from contaminants and UV rays when manipulating and sterilizing tools or materials in the chamber.
6. Chamber
   A vacuum chamber for sterilizing tools or materials in the Glovebox tool.

3.2. Questionnaire

The methods section should provide sufficient information for similarly qualified researchers to replicate the study. This section should include the study's design and materials, a detailed description of all interventions and comparisons, and the analysis employed. The instrument used to collect data is a questionnaire, a questionnaire is a data collection technique that is done by giving a set of questions or written statements to respondents to answer. Questionnaires are used to measure the quality of the media developed (Ponza et al., 2018). The questionnaire used by researchers is an expert validation questionnaire consisting of a media expert validation questionnaire, a material expert validation questionnaire, and a tool trial. In determining media and material validation respondents using the Simple Random Sampling method where in simple random sampling the sampling of population members is carried out randomly without regard to the strata in the population. The media expert in question is a lecturer who is competent in the field of Electromedical Engineering. The role of the media expert is to assess the feasibility of the learning media developed. Validation is done using a media expert questionnaire or users who will use it. The material expert in question is an electromedical expert who is competent in testing the material from the clinical laboratory learning media developed. His role is to assess and measure the feasibility of the material presented in accordance with the target media or users who will use it (Erlita et al., 2023).

The results of the validation of the Prototype of Arduino Uno-based Laboratory Glove Box with UV Lamp, Blower, and DHT22 Sensor for Learning Media using two questionnaires with each questionnaire as many as five statements addressed to five media expert validators and five material experts. The values for each answer choice are as follows:

- Strongly Agree = 4

- Agree = 3
- Disagree = 2
- Strongly Disagree = 1

4. Results and Discussion

4.1. Temperature and humidity data validation

Validation of room temperature and humidity data is performed by executing a comparison test between the DHT22 Sensor and the HTC-1 Thermo Hygrometer instrument, as shown in Table 1 and Table 2, when reading the room's temperature and humidity readings. Temperature and humidity parameters were tested three times each.

According to the results of testing the temperature parameters shown in Table 1, the DHT22 sensor's accuracy in reading the temperature value is 99.50%. While testing humidity parameters as shown in Table 2, the DHT22 sensor's accuracy in reading humidity values is 98.0%.

Table 1. Temperature data validation

Temperature Parameters Room Temperature of HTC-1 (°C)	DHT22 Sensor (°C)	Error DHT22 Sensor
25	25.50	0.50
25	25.50	0.50
25	25.50	0.50
Average measurement	25.50	
Error	0.50	
Accuracy	100 – 0.50 = 99.50 %	

Table 2. Humidity data validation

Humidity Parameters Room Temperature of HTC-1 (°C)	DHT22 Sensor (°C)	Error DHT22 Sensor
50	52	1.00
50	52	1.00
50	52	1.00
Average measurement	52	
Error	2.00	
Accuracy	100 – 2.00 = 98.00 %	

4.2. Product validation

Material expert validation is evaluated from three perspectives: quality, quantity, and advantages. The findings of the material expert validation are given in the bar chart in Figure 5, based on the results of filling out the material expert questionnaire in accordance with the objectives that were established.

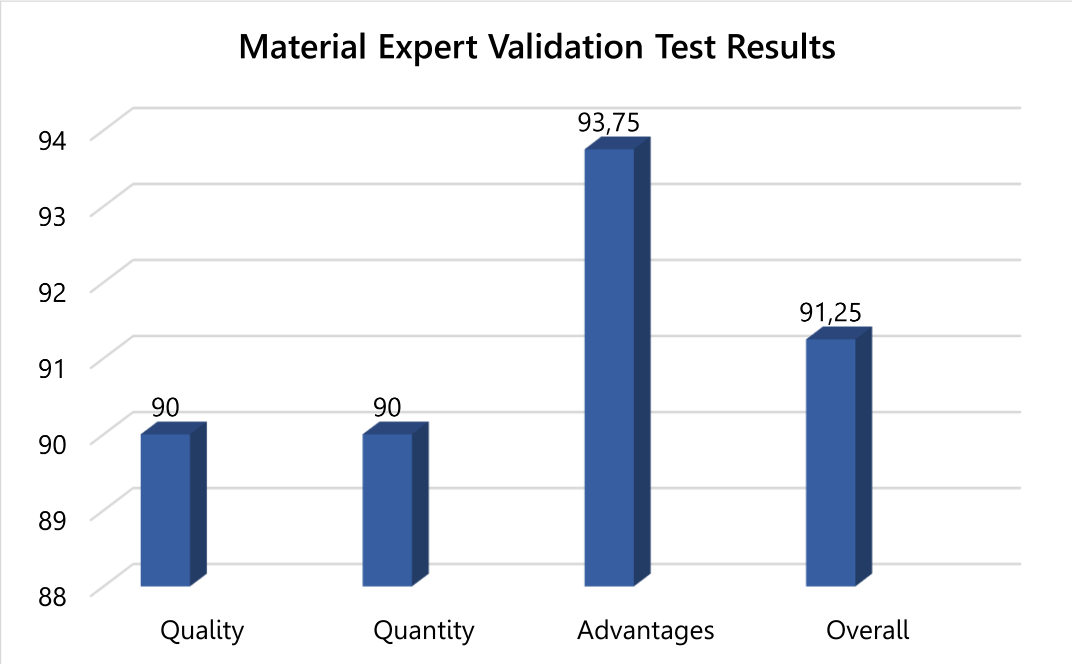

Figure 5. Material expert validation test results

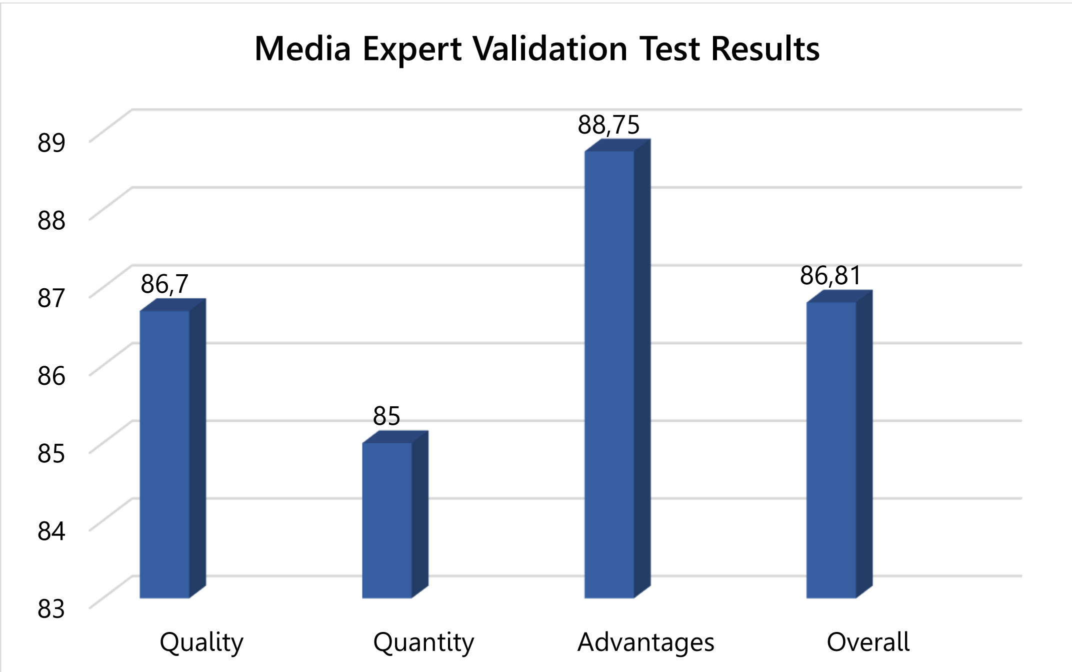

Figure 6. Media expert validation test results

The material expert assessment data is reviewed in terms of quality, quantity, and advantages. The percentages in terms of quality, quantity, and advantages are 90%, 90%, and 93.75% respectively. Overall, the level of validation of the tool based on the material expert's judgment was 91.25%, placing it in the category of very good use. Meanwhile, Figure 6 displays the results of the media expert validation test, which were obtained by completing the media expert questionnaire.

Overall media expert assessment data is examined in terms of quality, quantity, and advantages. In terms of quality, it receives an 86.7% rating, 85% for quantity, and 88.75% for advantages. Overall, the level of validation of the instrument from the media expert's assessment was 86.81%, indicating that it was very good to use.

5. Conclusion

Based on the test findings and conversation, we can take the following conclusions:

1. The laboratory glove box with Ultraviolet lights and DHT22 sensors for temperature and humidity monitoring, as well as a sterilizer chamber, is designed to operate as a learning aid.
2. The DHT22 sensor reads the room temperature with 99.50% accuracy, according to testing findings. While testing the humidity parameter, the DHT22 sensor has a reading accuracy of 98.00%.
3. The instrument was validated by material experts (91.25%) and media experts (86.81%), indicating it is very useful.

Given that the designed tool still has many flaws, here are some suggestions to help develop research, such as adding an Internet of Things (IoT)-based monitoring system that can store temperature and humidity reading data and an RFID-based door security system to prevent unauthorized access to the laboratory glovebox.

Conflict of interest

The authors declare that they have no conflict of interest.

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