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DESIGNING AND CONSTRUCTION OF A LOW-COST LABORATORY SLIDE DRYER

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ABSTRACT

Our project is about the design and construction of a low-cost laboratory slide as an immediate means to mitigate the problems associated with the delay in the drying of blood slides during the diagnosis of malaria in various local clinical laboratories, the team focused on designing a portable low-cost slide dryer which operates in a way that when the blood slides are inserted inside it, the optimum time taken to dry the blood slides is minimized making the task effective and effective.

The recent pandemic and endemic (COVID 19 and EBOLA) respectively have profoundly impacted global malaria elimination programs resulting in a sharp increase in malaria morbidity and mortality. To reduce this impact, unmet needs in malaria diagnostics must be addressed while resuming malaria elimination activities. Rapid diagnosis tests (RDTs), the unsung hero in malaria diagnosis, work to eliminate the prevalence of plasmodium falciparum malaria (species) through their efficient, cost effective and user-friendly qualities in detecting the antigen hrp2 (histidine _rich protein 2), among other proteins, however, the testing mechanism and management of malaria with RDTs presents a variety of limitations that is to say identifying of certain malaria parasites in blood.

When carrying out serological surveys, particularly in remote locations, it is of great advantage to have a method of collecting and storing blood samples which does not require that facilities for centrifugation and which is relatively robust to irregular degrees of refrigeration, at least for short periods.

Keywords*: Design, Construction, Laboratory Slide Dryer*
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INTRODUCTION

Laboratory equipments are essential for interactive students of science at all levels of education. The absence of these teaching aids makes the teaching and learning of science to be abstract. One way of solving the problem is through improvisation. Improvisation is the act of creating something or using something in the absence of the ideal tool. Science teachers of the entry to teach students about scientific principles through the use of about the experiments, though they do not always have access to their sources needed to optimally per form experiments. Innovative teachers can use cheaper products to simulate experiments. Teachers can also help students learn improvisation as an important life skill. Teachers can work with student to come up with ways to improvise, forcing students to think critically about the scientific concepts underlying the devices

Improvisation requires that students use resources available in the surrounding area. Despite having knowledge of the scientific principles, many students do not realize that they have plenty of resources available for lab experiments. Once the students beg into understand the principles behind improvisation, they can begin improvising their own tools. Also, a lot of students lack confidence in their abilities to design their own experiments (Pearson, 2013).

Zambia has established the National Science Centre to produce locally made laboratory equipment for interactive science institution. Under this arrangement, schools across Zambia can purchase laboratory supplies and apparatus .Local materials and labour are used, so expertise and capital are developed within the country, and the products are affordable (Malata and Landreman, n.d. According to UNESCO (n.d.) it is possible to build low cost equipment for science and technology education. These include simple test tube racks, tripod stands, simple gas generators, simple elementary balance, artificial lungs, etc. AUNDP (1982) project in Philippines established a centre for the design, production and distribution of school science equipment to improve science education. In the first phase of the project no less than 278 prototype items of general laboratory equipment.

EXISTING TECHNOLOGY

Existing technology of drying blood smear slide in the management of malaria oven heats its content via the principle of convection. The heating element is not located with the specimen chamber of the oven but in a separate external envelope.

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Figure 1 Laboratory oven

Figure 2 closed lab oven

MAIN OBJECTIVE OF THE PROJECT

Designed and constructed a low cost portable laboratory slide dryer for drying blood samples in the management of malaria.

SPECIFIC OBJECTIVES OF THE PROJECT

We designed a low cost portable device for drying blood samples in hospital laboratories.
We tested the performance of the device to see whether it met the appropriate measures such as safety, reliability, performance among others
To implement the working prototype in the laboratory so as to improve on the delay of drying blood samples.

CONCEPTION OF THE INNOVATION

PRODUCT DESIGN SPECIFICATIONS.

Usually the device requires to be opened the door hand and then the blood glass smear is placed inside for drying. Also a person needs to keep track when the blood slides are dried, should be removed for staining or examinations.

SAFETY

The device is well insulated with wooden material which is a bad conductor of electricity and does not cause electric harm to the laboratory user.

REUSABLITY

The device is long lasting, sustainable, strong and transformable.

ENERGY EFFICIENCY

The equipment operates with low power supply both on D.C and A.C. This power requirement is sufficient to supply all components involved on the device. This device is therefore in position of operating in areas with or without AC or DC power supply.

LOW PURCHASE

The device is affordable and of low cost for both low and high income earners, with an estimated amount of less than 57 US dollars.

RELIABILITY AND PERFORMANCE

The device is in position to operate whenever it is needed and also in position to perform its function appropriately with in a specific period of time that is to 5-10mins.

PROJECT IDEA GENERATION

During this process, the team used brainstorming technique to generate ideas. It involved radial thinking where possible solutions or ideas were generated out of which the most effective ideas were selected. It was a beneficial preliminary stage that involved free interaction of each and every one.

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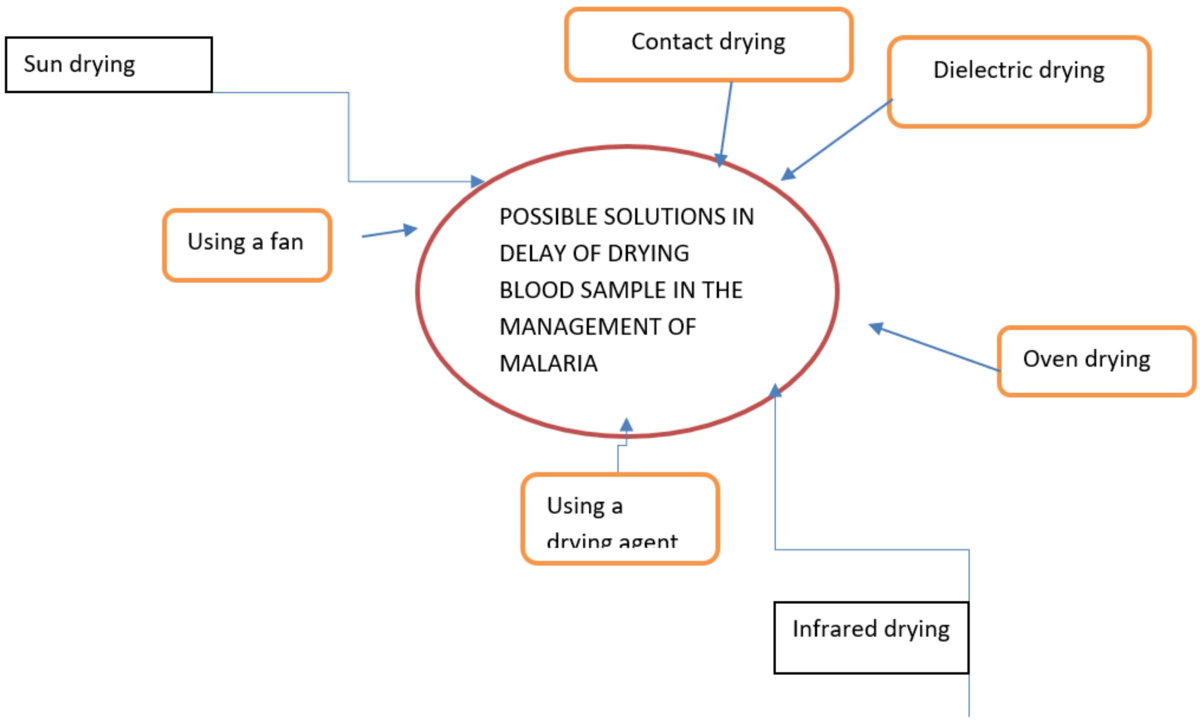
The team came up with the following solutions in attempt to mitigate this challenge.



PROJECT IDEA SELECTION.

This process involved selection of the most appropriate method of mitigating the challenge. During this process, these selections were made based on the ranking of the involved parameters whereby the best option carried the greatest score.

Criteria for success

KEY
Excellent – 5
Very good – 4
Good – 3
Fair – 2
Poor -1

RANKING CRITERA

Table 1 of the ranking criteria

PDS	INFRARED DRYING	FAN/BLOWER	OVEN DRYING	RANK (i)	%RANK (W1)
SAFETY	3	4	5	3	60
REUSABILITY	3	5	5	1.5	83
ENERGY EFFICIENCY	1	3	2	6	8
LOW PURCHASE	1	5	3	5	25
RELIABILITY	4	3	4	4	42
PERFORMANCE	5	3	5	1.5	83
TOTAL	17	23	24	21	301

NOTE: The lower number is the highest rank.
W1=1-((i-0.5)/n)
n- The number of specification

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DESIGNING AND CONSTRUCTION OF A LOW COST LABORATORY SLIDE DRYER TEMPERATURE FOR THE DRYNG OF BLOOD SIDES

The standard temperature for the drying of blood slides in a laboratory dryer is typically around 30-60 degree Celsius (86 to 140 degrees Fahrenheit) it is commonly used to ensure that the blood on the slides dries adequately without causing damage or altering the specimen.

NB

Selection of the bulbs to be used in the laboratory dryer;

Cool white filament bulbs (fall within a temperature range of 35 to 50 degrees Celsius)

Led bulbs (generally fall within the range 25 to 50 degrees Celsius)

CALCULATIONS ON THE NECESSARY BULBS TO BE USED TO ENSURE APPROPRIATE DRYING OF THE BLOOD SLIDES

Power of the bulb (commonly 10 to 60watts)

The size and specification of the lad dryer: this will also affect the heat distribution and overall performance.(34x36x63cm)

Temperature reached by one 6watt bulbs----200 degrees Celsius

Conversion of the measurements to inches **(**we consider dividing each value by 2.54 since 2.54 is an inch)

Length= (34/2.54 = **13.4**) inches

Width = (36/2.54 = **14.2**) inches

Height= (63/2.54= **24.8**) inches

Efficiency—80%

Heat output of the bulbs

Power consumption of the fan.

Calculations

Each bulb produces 6 watts of heat energy, therefore.

Assume n—no. of bulbs

Total heat output of bulbs=6n

Effective heat output

Fan's power consumption- total heat output required

Required heat output 500watts

So, (k-500) W

The effective heat output per bulb=effective heat output/no. of bulbs

= (k-500/n)

Total heat output from bulbs;

=effective heat output per bulb **x** no. of bulbs

100n = ((k-500)/n) x n

3.2 MATERIAL ANALYSIS AND JUSTIFICATION

One material was in used in the design and construction of the portable laboratory dryer. This was wood material, its criterion and justification is as follows.

NO	CRITERION	JUSTIFICATION
1	Thermal insulation	Wood is a natural insulator, which means it can provide good thermal insulation properties. This can help in maintaining a stable temperature inside the laboratory dryer, reducing heat loss, and optimizing energy efficiency.
2	Non- reactive	Wood is generally non reactive to most chemicals, making it suitable for use in a laboratory setting. It is less likely to react with the substances being dried, minimizing the risk of contamination or undesired chemical reactions
3	Durability	The durability of wood depends on the specific type of wood used and how it is treated. Certain types of hardwood, such as oak or maple, can be quite robust and resistant to wear and tear
4	Aesthetics and environment	Wood can provide a visually appealing and warm aesthetic, which may be desirable in some laboratory settings. Additionally, wood is a renewable resource and if sourced responsibly can be more environmentally friendly compared to certain synthetic materials.

Table 2 showing material analysis and justification

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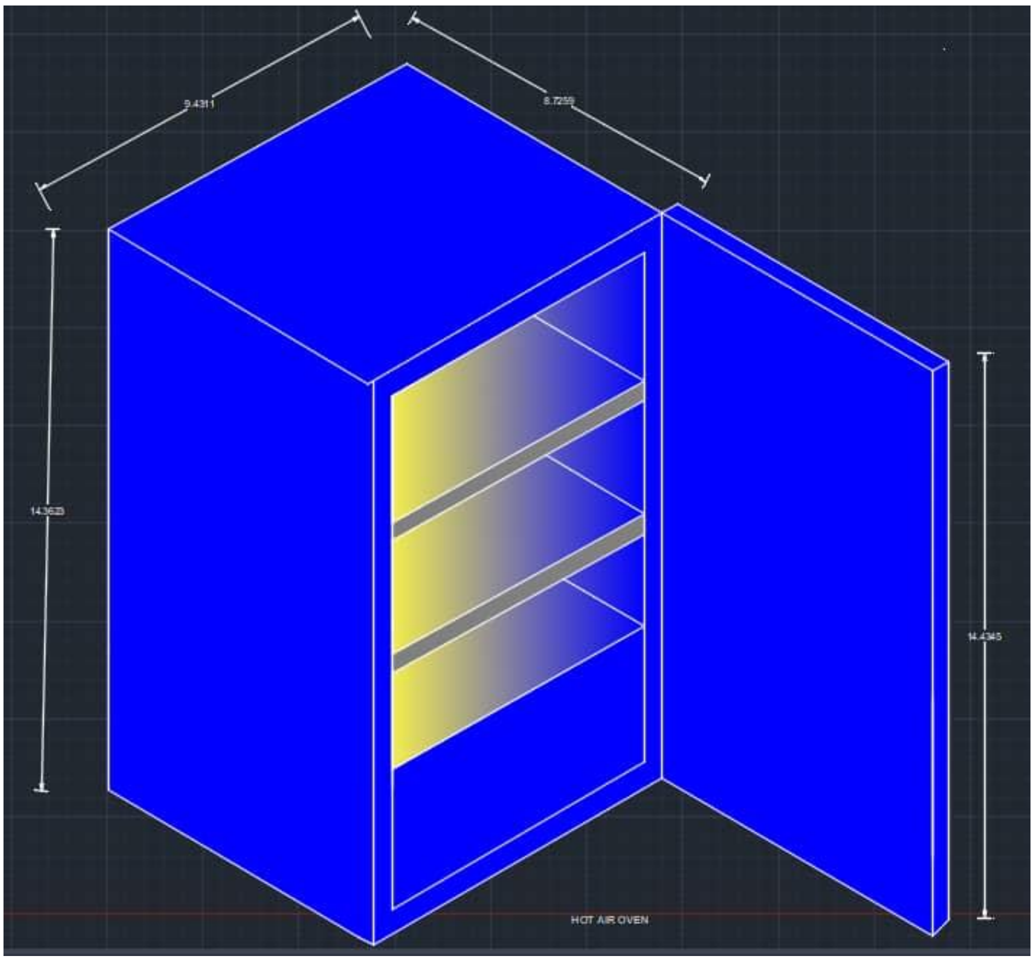
PRINCIPLE OF OPERATION

The radiation principle utilized in generating heat from bulbs used in drying blood slides is based on the principle of thermal radiation. This means the emission of electromagnetic waves by an object due to its temperature, this emission occurs across a wide range of wave length

DESIGN LAYOUT DRAWING
3D DRAWING

Figure 3 the 3D of the low cost laboratory oven



MECHANISM OF OPERATION

The mechanism of operation falls under the following stages;

Heating element in the laboratory slide dryer

In the case of the bulbs used, they typically contain a filament made of a material such as tungsten. When an electric current passes through the filament, it heats up due to resistance offered by the material. As the temperature of the filament increases, it emits thermal radiation in the form of infrared waves.

The emitted infrared radiation possesses energy, and when it comes into contact with the blood slide, the energy is transferred to the object, causing it to heat up. This transfer of energy occurs through the process of radiation. The blood slide absorbs the emitted infrared radiation and converts it into heat, which aids in the drying process.

Air circulation

The purpose of this is to facilitate the evaporation of the moisture from the slide by constantly moving the air around them. In this case we consider using a fan.

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Insulation

The insulation helps to minimize heat loss from the dryer's interior to the external environment. It keeps the heat contained within the dryer, allowing it to maintain a consistent temperature.

Slide placement

The slides are positioned vertically into the slots on the rack inside the dryer. The slot holds the sides securely and prevents them from falling or sliding out.

Complete drying

Once the slides are completely dry, they can be removed from the dryer and used for further analysis or preparation such as mounting specimens for microscopy.

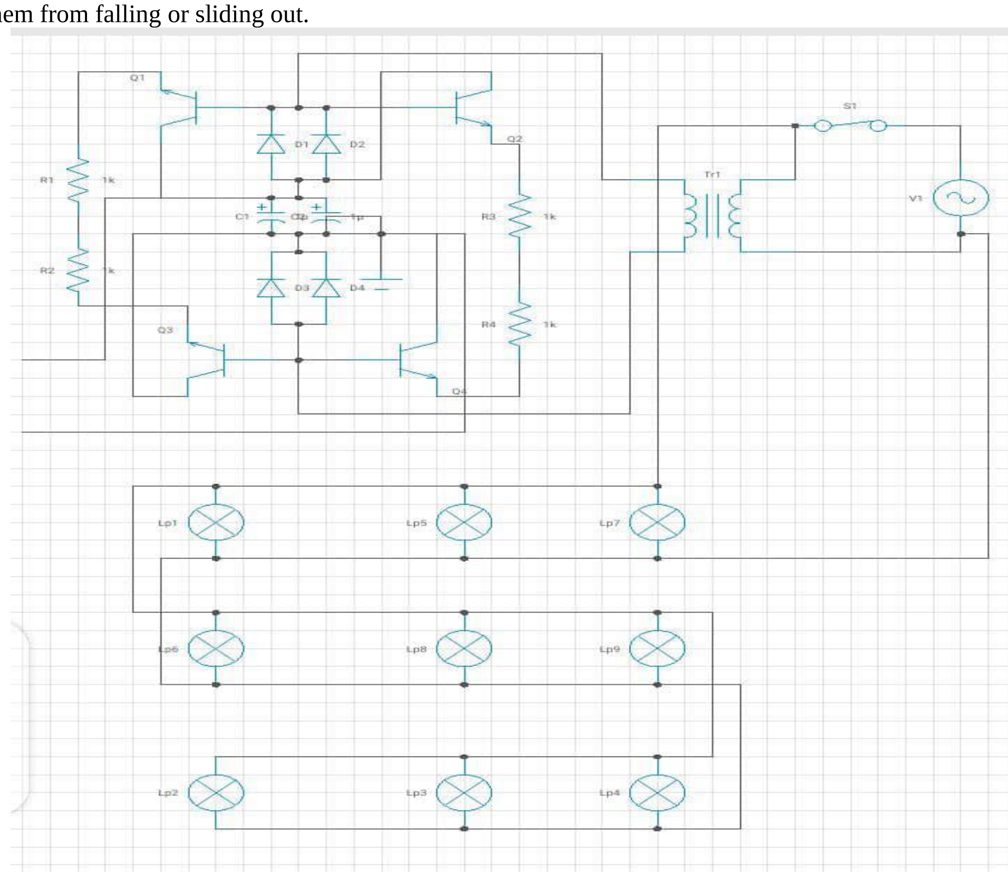

Figure 4 showing the circuit diagram of a laboratory slide dryer

Figure 5 showing a finished laboratory slide dryer

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PROTOTYPING

Figure 6 *showing the measurement of the Low cost laboratory oven*

The measurement of the case

Height- 63cm
Length-34cm
Width-36cm

Figure 7 ***showing the screwing the components on the Low cost laboratory slide dry***

Testing of the components on the circuitry

- Testing of the continuity of the components

Regulators
Silicon diodes
Capacitors
Resistors of 100k ohms

- Testing of the AC power for the bulbs 240vols
- Testing of the voltages of DC power for the fans 12vols.

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Figure 8 showing the connection of bulb holders

Figure 9 showing the moulting of thecomponents on the laboratory casing

Figure 10 showing the assembling of the Low cost laboratory slide dryer

FUTURE ASPECTS OF THE PROJECT

Our device is to meet the following needs in the nearby future;

1. Automation and Smart features, our device is more likely to incorporate advanced sensors for temperature and humidity and connectivity to laboratory information systems for data management.
2. Energy efficiency, the device may be designed to consume less energy and have a smaller environmental foot print.
3. Multi-functionality, our device might incorporate multiple functionalities, such as combining slide drying with staining or other sample preparation steps, making the equipments more versatile and efficient.
4. We are to incorporate metal casing to enable our device look sleek and modern which may be appealing to researcher and scientists and to improve on its hygiene and cleaning processes.

CHALLENGES FACED

1. We faced difficulties in coming up with a solid design that meets the requirements of the laboratory slide dryer. This involved understanding the principles of slide drying, considering the size and dimensions of slides, the heat source and air circulation.
2. We also faced difficulties in choosing the right type of wood that would ensure the durability and stability of the slide dryer.
3. Also faced challenges in choosing the appropriate components for heat source, heating element, fan and other components that would ensure safe and efficient functioning of the dryer.

4. Safety concerns in working with electrical components, heating element and wood working tools posed safety risks.
5. Budget constraints, limited financial resources when purchasing materials and components for the project as the school didn't provide any financial assistance
6. Time management, we faced challenges in balancing time for other academic commitments with the project work as the designing and construction of the laboratory slide dryer is a time consuming process.
7. Documentation and reporting, keeping details, records of the design, construction process and testing processes.

SOLUTIONS

1. The school's involvement in the financing of their student's designing and construction processes including transport fees.
2. The school should have a workshop where students could carry out their practical work from.

CONCLUSION

In conclusion, the journey of designing and construction of a laboratory slide dryer has been both challenges and recording. Throughout this process, we have encountered numerous obstacles but each challenge presented an opportunity to learn and grow.

As a team, we have demonstrated resilience, creativity and problem solving skills to overcome technical hurdle and make our vision a reality.

We believe our lab slide dryer stands as a testament to the power of determination to academic excellence and our passion for innovation solutions in the scientific community.

As we present our final creation, we are eager to share our knowledge and experiences with the hope of inspiring others to embark on their own ventures of exploration and discovery. The journey may be arduous, but the knowledge gained and the skills honed along the way will undoubtedly shape us into better, more capable individual.

In closing, we invite you to witness firsthand the culmination of our hard work, the wooden laboratory slide dryer. May it serve as a reminder that with dedication, teamwork and unwavering spirit, we can conquer any challenge and make meaningful contributions to the scientific world.

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LIST OF ABBREVATIONS

N.D.B.E: National Diploma in Biomedical Engineering
Eng: Engineer
LEDs: Light Emitting Diodes
MoH: Ministry of Health
W.H.O: World Health Organization.
PDS: Product Design Specification.
AC: Alternating Current
DC: Direct Current
LCPWBED: Low cost portable wooden box electric dehydrator
CDC: Centers for Disease Control and prevention

Source of funding

The study was not funded.

Conflict of interest

The author had no conflict of interest.

Author Biography

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