



**LAKE SHORE EDUCATIONAL INSTITUTION**

A. Bonifacio St. Canlalay, Biñan City, Laguna

**PERCEPTION ON THE USE OF FOLDSCOPE AS AN ALTERNATIVE  
CONVENTIONAL MICROSCOPE**

**A Thesis**

**Presented to the Faculty of the  
Senior High School Department  
Lake Shore Educational Institution  
Canlalay, Biñan City of Laguna**

**In Partial Fulfillment of  
The Requirements for the Subject of  
Practical Research 2**

**by**

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**RECOMMENDATION FOR ORAL EXAMINATION**

This thesis entitled "**Perception on the Use of Foldscope as an Alternative Conventional Microscope,**" prepared and submitted by **Kyle Carlo C. Lasala, Kingsley S. Almeda, Giuliana Maria R. Bautista, Kate Camille R. Cortez, Louise E.J. A. Magbitang, and Christian Ashley D. Quimzon** in partial fulfillment of the requirements for the subject **Practical Research 2** has been examined and is recommended for Oral Examination.

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### **DEDICATION**

We, the researchers, wholeheartedly dedicated this study to our beloved parents, who have been our source of inspiration and strength, who continually provide their moral, spiritual, emotional, and financial support.

We dedicate this study to our research advisers, friends, and classmates who shared their words of advice and encouragement to finish this study. We also include our Alma Mater, Lake Shore Educational Institution, and future researchers in our dedication. Students and researchers are very much welcome to use our study for reference.

We also dedicate this study to Foldscope Instruments, Inc., which envisions frugal science to develop and establish the scientific community.

And lastly, we dedicate this study to Almighty God, who gave us additional strength and power of the mind and the protection and skills while presenting the significant study.



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### Thesis Abstract

<b>Title</b>	: Perception on the Use of Foldscope as an Alternative Conventional Microscope
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This study aimed to determine the feasibility of Foldscope to be an alternative microscope. This study also utilized a quantitative non-experimental correlational research design and employed purposive quota and availability sampling technique to senior high school students taking up Science, Technology, Engineering, and Mathematics (STEM) strand.

Specifically, this study answered the following questions: (1) What is the level of usability of Foldscope as an alternative microscope in terms of accessibility, durability, and portability? (2) What is the level of feasibility of Foldscope as an alternative microscope in terms of operational feasibility and technical feasibility? (3) Is there a significant relationship between the level of usability and feasibility of Foldscope as an alternative microscope?

Based on the results of the study, the following conclusions are drawn: (1) Foldscope as an alternative microscope is highly functional based on the preconceived opinion of the students. (2) Foldscope as an alternative microscope is highly feasible based on the preconceived opinion of the students. (3) The Foldscope's level of usability is directly proportional to its level of feasibility. There is a positive, strong correlation, and the null hypothesis is rejected. The features of Foldscope under usability determine its feasibility.

*Keywords: Perception, Foldscope, Alternative Microscope*



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## Chapter 1

### THE PROBLEM AND ITS BACKGROUND

This chapter contained the introduction of the study, objectives, theoretical/conceptual framework, operational framework, statement of the problem, hypothesis of the study, assumption of the study, scope and delimitation, significance of the study, and definition of terms.

#### Introduction

Learning science concepts comes both experiential and experimental. Davey (2019) stated that when scientific concepts or theories were illustrated in a real-life situation through field and laboratory activities, students develop a better understanding. Discovery learning is a proven more efficient way of learning than traditional learning in science. In a study conducted by Resmawati et al. (2018), the students' learning outcomes in discovery learning about temperature and heat matter provided positive responses. The studies are valid reasons why experiments are one of the most effective activities of the subject. To conduct experimental activities, one must rely on laboratory apparatuses to measure or observe most of the time. Accurate measurement and observations lead to the most groundbreaking ideas of science. For instance, the invention of the microscope made researchers understand the biological concepts people know today. It is an essential intuitive learning tool today that can engage both the students and the teachers. According to Marcus (2017), students' points of view may change to become more significant if provided by accessible tools to observe the microscopic world. It is the window between



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the familiar world and the world where small creatures such as bacteria are present. In the past and present generations, engaging activities involving the microscopic world are becoming more vital in biology.

Visperas (2011) stated there is a significant shortage of laboratories and equipment in the Philippines. Only four thousand sixty public high schools out of five thousand three hundred fifty-nine (4,060/5,359) have laboratories in the whole country and a ratio of one thousand three hundred twenty-five students for every one laboratory (1,325:1) from an expert's statement. The effect of the situation is students' lack of interest and poor performance in science. The problem should not be a subject of ignorance. It is the root cause why the Philippines is considered a third-world country. According to Mejia (2020), science and technology are essential in a country's development, but the Philippines is not supporting it, causing aspiring scientists to be left behind. It is the shortage of apparatus and laboratory areas that hinders the learning experience of learners.

One of the laboratory apparatuses that has been experiencing shortage is the microscope, which is essential in studying biological contexts. It is a tool that can be used for actual experimental activities such as observing microorganisms. In a study conducted by Rosier (2017), most students prefer interactive learning in biology. In another study conducted by Iskandar et al. (2013), microscopy was considered the supporting aid to interactive learning in biology. Without microscope interaction, students purely rely on textbooks and have difficulty in learning. The students have no interest in the subject if done with conventional teaching. On the other hand, a microscope can stimulate the curiosity and interest of the learners. Therefore, providing apparatuses such as microscopes



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can significantly help to improve the environment for learning and should become accessible. The problem was that conventional microscopes were expensive and cannot be distributed quickly.

One practical solution that has been offered is the use of an alternative microscope called a Foldscope. Manu Prakash developed it in 2014, especially for poor areas. The tool became an alternative microscope to other countries. In India, poor communities do not have access to expensive conventional microscopes that can help them to diagnose the disease quickly. With the affordable and portable Foldscope, people can use the tool to detect parasites. People can now prevent the possibility of having malaria. Prakash also taught his students about microscopy physics with Foldscope. It can also become an alternative microscope for better education for children to stimulate interest in biology (CBC News, 2014). Prakash and his team initially started the Foldscope project in 2014. The team composed the microscope with materials that sum up to only half a dollar. With the help of an American public benefit corporation, Kickstarter, the team successfully raised money. They did a massive production of the project to provide everyone a portable and affordable microscope. It became an educational tool and reached the poor communities to provide microscopy experience (Sridharan, 2018).

Many researchers harness the capability of the Foldscope to use in different fields. It already became a subject of researchers in medical diagnostics, animal health, agriculture, education, sanitation and hygiene, public health and awareness, biodiversity, machine learning, and many more. Past researchers tested the capability of Foldscope in using biological research projects. With the assistance of staining technique, hematoxylin



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and eosin stain, researchers observed salivary glands, intestine, and neural cells. They reported that it is possible to spot the cell alterations, cell counts, and nuclei in Foldscope. The conclusion was significantly capable in biological researches (Denaro F et al., 2018).

A field researcher also tested Foldscope in Peru to observe and identify exotic organisms. The field biologist encountered issues using a conventional microscope while bringing it to the Amazon forest and found that the microscope is not effective in field research due to the environment. The biologist searched for an alternative microscope to continue his field research and found Foldscope. Foldscope was used and became significant to his research. Foldscope solved all the issues of the conventional microscope. For the researcher, Foldscope is a portable tool that can help determine organisms in the forest (O'brien, 2015).

Given the situation and in the light of this foregoing, the researchers sought interest in pursuing the study focusing on the feasibility of Foldscope as an alternative microscope. Furthermore, this study gave information on how the said material can maximize every student's learning experience, especially in learning science.

### **Objectives of the Study**

The study entitled "Perception on the Use of Foldscope as an Alternative Conventional Microscope" generally aimed to determine the feasibility of Foldscope to be an alternative microscope.

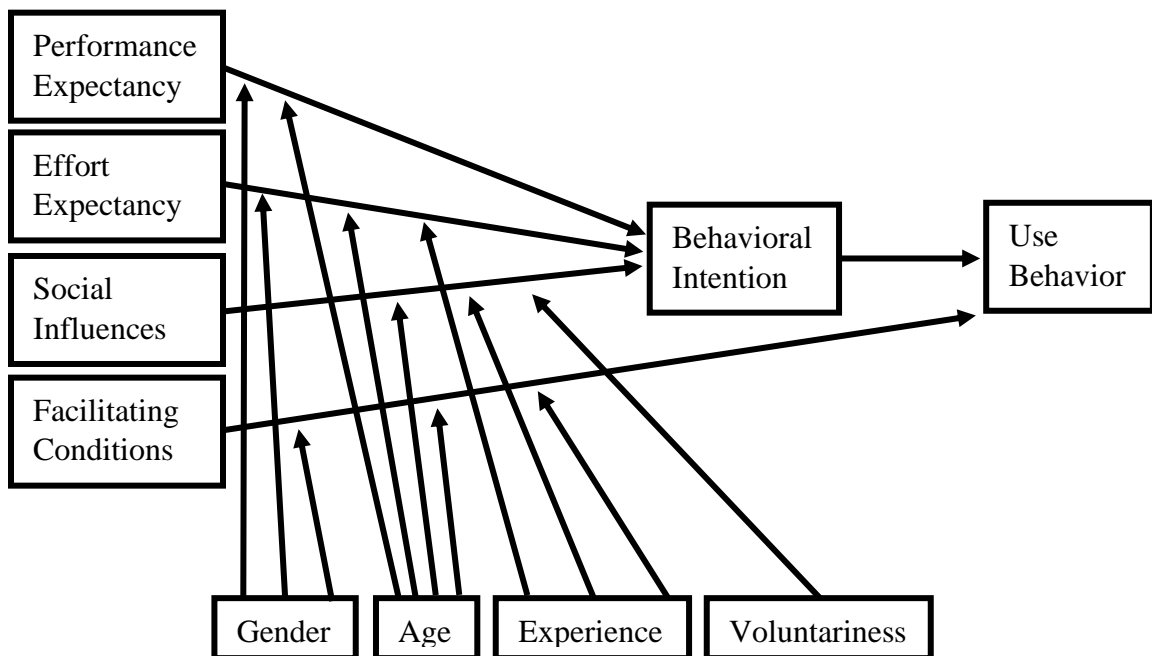
Specifically, it aimed (1) to determine Foldscope's features as an alternative microscope; (2) to evaluate Foldscope as a feasible alternative microscope; and (3) to



promote Foldscope as a teaching tool for science teachers if the Foldscope is feasible as an alternative microscope.

### **Theoretical Framework**

The study was anchored on the Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh et al. (2003), which focused on determining the relationship of the user and the acceptability of the proposed system or technology. The UTAUT developed by Venkatesh upgraded the model of Technology Acceptance Model (TAM) by Richard Davis in 1989 through elaborating the two main variables, usefulness and ease of use; and added up the profile of the users into the expanded variables, which are performance expectancy, effort expectancy, social influence, and facilitating conditions.



*Figure 1. Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003)*



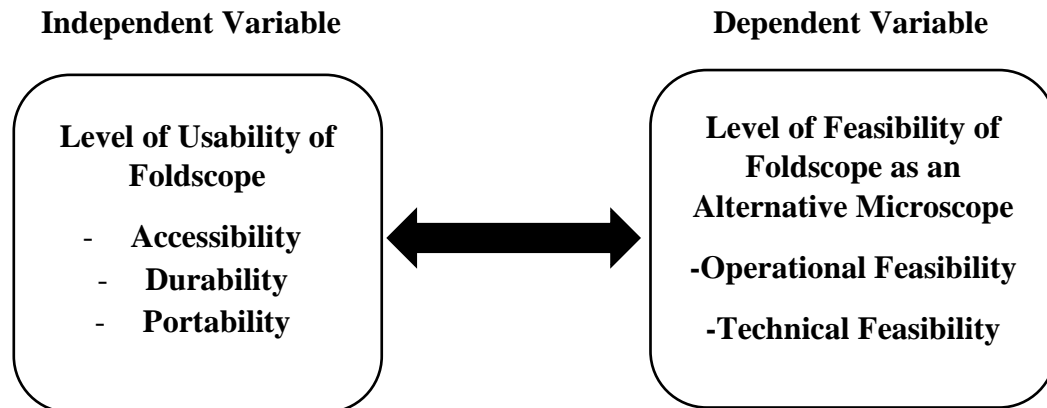
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Figure 1 showed the model of the UTAUT of Venkatesh et al. (2003), which showed the complexity of the relationship between the user and the technology being proposed. Based on the model, the profile that includes gender, age, experience, and voluntariness is related to performance expectancy, effort expectancy, social influences, and facilitating conditions and has something to do with behavioral intention and behavior. The model explains that gender influenced the performance expectancy, effort expectancy, and facilitating conditions; age influenced the performance expectancy, effort expectancy, social influences, and facilitating conditions; experience influenced the effort expectancy, social influences, and facilitating conditions; and voluntariness influenced the social influences. Furthermore, performance expectancy, effort expectancy, and social influences lead to behavioral intentions and later influenced behavior, while facilitating conditions direct led to its influence on behavior. In this study, the measure of feasibility of Foldscope as an alternative microscope has something to do with its usability as perceived and experienced by the respondents.

### **Operational Framework**

The study was anchored on the Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh et al. (2003), which focused on determining the relationship of the user and the acceptability of the proposed system or technology.



*Figure 2. The Operational Model of the Study*

Figure 2 showed the operational model of the study. The considered independent variable was the level of usability of Foldscope, which included its accessibility, durability, and portability. On the other hand, the dependent variable of the study was the feasibility of Foldscope as an alternative microscope in terms of its operational and technical feasibility. Lastly, the study determined the relationship between the two variables.

### **Statement of the Problem**

The study entitled "Perception on the Use of Foldscope as an Alternative Conventional Microscope" generally aimed to determine Foldscope's feasibility as an alternative microscope.

Specifically, it sought the answer to the following questions:

1. What is the level of usability of Foldscope as an alternative microscope in terms of:
  - 1.1. accessibility;
  - 1.2. durability; and,



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- 1.3. portability?
2. What is the level of feasibility of Foldscope as an alternative microscope in terms of:
  - 2.1. operational feasibility; and,
  - 2.2. technical feasibility?
3. Is there a significant relationship between the level of usability and feasibility of Foldscope as an alternative microscope?

### **Hypothesis of the Study**

The researchers formulated the hypothesis stated and answered with statistical treatment.

$H_0$ : There is no significant relationship between the level of usability and feasibility of Foldscope as an alternative microscope.

### **Assumptions of the Study**

The researchers based the study on the following assumptions:

1. The usability of one's product determines its acceptability.
2. A product is feasible if it is capable of carrying out a particular task design for its use.
3. The respondents are honest in answering the survey questions.





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### Scope and Delimitation

This study determined only the feasibility of Foldscope as an alternative microscope in its operational and technical aspects and its usability level, which included accessibility, durability, and portability based on the perception of the students. The study surveyed 60 Science, Technology, Engineering, and Mathematics (STEM) students currently enrolled this A.Y. 2020-2021 at Lake Shore Educational Institution. Furthermore, it utilized purposive quota and availability sampling due to the current situation, which was pandemic.

### Significance of the Study

The study would benefit the following:

The **STEM students and other students** would gain a deeper understanding of the context they are studying, particularly in Biology class, once that this study would prove the Foldscope's feasibility from the preconceived opinion of the respondents. Furthermore, given its expected outcome, the proposed product would also help them gain access to the scientific tool and explore the microorganisms anywhere and anytime. The students' exposure to microscopy would stimulate curiosity and develop scientific thinking. They would gain access to scientific tools with ease and convenience without worrying about the cost and damage risks.

The study would help the **teachers** to gain an insight into the product's feasibility as a learning tool for their students. Teachers can create an idea to use the product for activities in biology classes with the tool. The study leads the teachers to the perspective



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of students in using the product. They would understand the students' insight into microscopy.

The study would provide in-depth information for the **Department of Education** to recognize Foldscope's feasibility and potential as an educational tool. It would help them realize the importance of a microscopic device in biology classes, especially during a pandemic where learning materials are limited. The study would serve as their reference for consideration and further understanding of the proposed tool.

The study would help the **current researchers** to gain knowledge and insight through searching across the internet, reading background information about the proposed tool, assembling, and experiencing the Foldscope. It provides the facts and findings that would guide them to execute activities with ease and comfort. The researchers gain an advantage as the foremost local researcher regarding the topic and propose a solution to providing quality education.

The study would guide **future researchers** to get helpful information on using Foldscope as an alternative microscope in biology class. The research paper would serve as their reference to gain information about the Foldscope.

### **Definition of Terms**

For a better understanding of the concept of this quantitative inquiry, the following terms were defined both conceptually and operationally.

**Perception** is an idea, a belief, or an image you have as a result of how you see or understand something, according to Oxford Learner's Dictionary. In this study, perception



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is the impression of the students to the usability and feasibility of Foldscope in the virtual demonstration.

**Foldscope** is an origami-based microscope with 140x magnification. It was designed to be an affordable, durable and portable microscope. In this study, Foldscope is the proposed product of the researchers and is often called the "alternative microscope."

**Alternative** is a thing that you can choose to do or have out of two or more possibilities, according to Oxford Learner's Dictionary. In this quantitative inquiry, it is the description given to the Foldscope as a microscope.

**Microscope** is a scientific tool used to discover microorganisms. In this study, it is the tool to compare with Foldscope.

**Usability** is the quality or state of being usable according to Merriam-Webster Dictionary. In this quantitative inquiry, it is a measure alongside the Foldscope's accessibility, durability, and portability and considered as the independent variable.

**Accessibility** refers to how easy something is to reach, enter, use, see, and many more, according to Oxford Learner's Dictionary. In the study, it is considered as an independent variable that refers to product availability and product cost.

**Durability** is the quality of being able to last for a long time without breaking or getting weaker, according to the Oxford Learner's Dictionary. In the study, it is considered as an independent variable that refers to the longevity and stability of the product.



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**Portability** refers to the quality of being easy to carry or to move, according to Oxford Learner's Dictionary. In the study, it is considered as an independent variable that refers to the size, weight, and convenience to handle.

**Feasibility** is the quality of being possible and likely to be achieved, according to Oxford Learner's Dictionary. In this quantitative study, it is the point of measurement to be used regarding Foldscope, alongside its operational and technical terms.

**Operational Feasibility** is the ability to utilize, support, and perform the necessary tasks of a system or program, according to Writer (2020). In this study, operational feasibility refers to how Foldscope performs as the alternative conventional microscope in the perception of the students.

**Technical Feasibility** assesses the details of how a system or individual intends to deliver a product or service to a customer, according to Wolfe (2019). In this study, technical feasibility refers to how applicable Foldscope to learning based on the perception of the students.

**Unified Theory of Acceptance and Use of Technology (UTAUT)** is a theory developed by Venkatesh that shows the relationship of the user and the acceptability of the use of one's product. In this quantitative study, it is the theoretical basis of the researchers.



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### Chapter 2

#### REVIEW OF RELATED LITERATURE AND STUDIES

The chapter reviewed the related literature, which substantiated and supported the details of the comprehensive study. It also provided a synthesis of the reviewed related literature and a discussion of the gaps bridged by this research.

##### **State of the Art**

The researcher presented both local and foreign literature and studies to provide a comprehensive background of the problem under study. Concepts, findings, theories, and notions from scholarly research and articles presented may later be fortified, negated, or improved by the additional knowledge that this study provided.

##### ***Viewpoint about Foldscope***

The Gubbi Labs, a research collective social enterprise, conducted numerous workshops across India with Dr. Jim Cybulski, the co-inventor and CEO of Foldscope Instruments. With the Foldscope's help, the learners can now explore curiosity in science and nature. The teachers are the students' source of knowledge. The Gubbi Labs partnered with the India Literacy project to educate the teachers in India's rural areas about Foldscope's efficiency in teaching biology and environmental science classes. Besides the training program for lecturers and pupils, the veterinarians held another workshop at Veterinary College in Shivamogga. Foldscope is a must-have portable tool compared to a 3-kilogram conventional microscope. The device is not just for students, teachers,



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researchers, and scientists but also for every individual that seeks adventure, knowledge, and excitement in the microscopic world (Gubbi Labs, 2019).

### *Accessibility of Foldscope*

The paper microscope makes microscopy affordable to anyone. The Foldscope creators' goal is to make scientific tools accessible to everyone all over the world. A paper microscope that costs only about a dollar to build became helpful to resource-poor areas. One of the creators claims that microscopes must become accessible like a pencil. Paper is generally more cost-effective and more uncomplicated to shape than other materials; it does not take much space and can be quickly and effectively transported worldwide. Another significant advantage of paper is the capability to be folded with a provided instruction. Most of the scientific tools today require more resources to acquire accuracy and precision in measurement. However, paper folding also can achieve it and can lessen the cost of resources (Barker, 2018).

### *Portability and Durability of Foldscope*

Aaron Pomerantz, a field biologist from Tambopata Research Center in Peru, experimented with Foldscope. The field biologist found that a conventional microscope is ineffective for the field due to growing fungi in the tool's glass. The humidity and environment of the rainforest made the tool ineffective and not durable. Pomerantz discovered Foldscope and found it interesting to use in his field research. Foldscope was immediately tested in his research in the Amazon forest. The researcher stated that the lens is the most crucial part. As long as the lens is working, no problem or issue was



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encountered. Pomerantz also stated that Foldscope cannot replace conventional microscopes but plays a massive advantage in a situation he encountered. Due to the practicality, portability, and durability, the tool became significant for field research. According to the researcher, most of the unidentified species can be found through a tool such as Foldscope. It is also essential that the tools today became flexible and adaptive to "smart" devices to enhance the capabilities. In the field research, Pomerantz used a smartphone to view the specimens with ease. The process of documentation became easy if the tool was adaptive to "smart" devices (O'brien, 2015).

### ***Importance of Microscopy***

Microscopic study is central to detect illness, with different approaches often depending on advanced laboratory instruments and capital resources. There are advantages to a microscope that can fit into a pocket and costs only one dollar, and the use of Foldsopes for medical evaluation is also in progress. The Foldscope has a further, similar use in teaching. There is a rising public curiosity in science. Encouraging people to discover the microscopic world with the portable microscope offers a way to increase interest in the subject. The gains of a knowledge-based public have come from the cooperation of scientists and people. Communication between scientists and the public is advantageous to both sides, who benefit from each other. The London School of Hygiene and Tropical Medicine relies on microscopy for the detection of illness. It is hard to practice a microscopic topic without access to laboratory facilities. Public engagement programs have enabled people to improve the ability to explain scientific ideas. Learning is to



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produce presentations that can draw school children's interest and scholarly demonstrations to students (Robinson, 2016).

### ***Mechanism of Foldscope***

Prakash thought that microscope is expensive and impractical due to the cost of the tool. Prakash had an idea to construct a microscope that can solve the issues. A nano-scale precision adjustment of focus for the lens, manual control of stage through thumb, and eye-viewing principle is the Foldscope's basic concept. The tool uses a cheap lens and a light-emitting diode powered by watch batteries. Prakash extended the research by upgrading the magnification and resolution of the tool. As a result, the tool can provide magnification from 140x magnification up to 2000x magnification power (Prakash, 2018).

### ***Objective of Foldscope***

The Foldscope Instruments company was founded in 2015 with a vision of worldwide distribution and the elaboration of "frugal" science. The Foldscope researchers find ways to improve and extend the use of the tool in different domains until now. Alongside "frugal" science, the company envisions providing a microscopic experience to children and developing scientific curiosity. The creator states that every child should carry a microscope in a pocket (Prakash, 2018).

### ***Impact of Foldscope in Learning***

According to Wittenburg and Osborne (2021), Foldscope can significantly initiate curiosity for students. Students already learned anatomy and geology through Foldscope. In terms of academic performance, learners can now participate virtually by sharing





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observations remotely while using Foldscope. Parents were influenced by their children and became interested in Foldscope also. Teachers were also interested and excited about Foldscope and the works of the students. Student-teacher interaction improved through hands-on learning. As a result and considering hands-on learning, the teachers requested more Foldscoptes to provide quality education.

### ***Experience in Using Foldscope***

According to Anna Budich (2016), a program is needed to increase children's understanding and knowledge of the world, especially in the environment, through a variety of topics such as science and the arts. The onion skin is used as a sample for the experiment. Each individual had a chance to see the sample using the Foldscope. Afterward, the children illustrate based on their observations. The learners offered different descriptions of observations using the same sample. At the end of the session, the children became more eager to hear that the Foldscoptes are used in class. Overall, the program was a success story. Children were exposed to microscopes and could experiment with Foldscope.

### ***Foldscope in Rural Areas***

The Overseas Community Involvement Program or OCIP team from Lee Kong Chian School of Medicine or LKCMedicine conducted a microscopy lesson in Langub High School in Davao City. Establishing a scientific community in poor-resource areas is one of the team's initiatives. The mission is to develop education and health programs in the area. The team aims to stimulate students to autonomous learning by providing an



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accessible and portable tool, the Foldscope. The team also conducted the lesson after class for grade 7 and grade 9 students of the school. The science lesson was about the Foldscope and how the learners can harness the tool's capabilities. The facilitators encourage the teachers to continue the team's Foldscope project to promote students' curiosity and acquire a scientific mind (Chew, 2018).

### ***Foldscope in Learning Activity***

The main goal of the activity is to teach the learners to see things differently and appreciate little things. The club hosted a game to stimulate interest from the children with the use of Foldscope. The facilitators gamified the experiment for the children for them to learn and enjoy. Then, facilitators asked the learners to observe and compare the given specimens such as tomato and onion skin cells through Foldscope. After the task, the learners should draw the specimen in the experiment. The second part of the experiment was about the difference between salt and sugar. Although salt and sugar are difficult to classify, the children learned the difference between them using microscopy. After the game, the hosts demonstrate how to observe the different parts of plants in Foldscope. The learners were tasked again to draw what was observed (KIDS Club Philippines, 2016).

### ***Observing through Foldscope***

Adorna (2019) observed freshwater microorganisms that live on top of a tree. The researcher initially intended to capture any underwater zooplankton to observe through Foldscope. Unfortunately, the plankton did not survive since fragile forms collapsed instantly. The strategy to gather moss from trees that flourished along the beach can be



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done by hydrating the formerly dry habitat for 24 to 48 hours. Adorna squeezed the moss and started gathering drippings in two days to check for tardigrades. It does not have a single tardigrade, according to the findings. On the other hand, a pond water study includes a wide variety of microorganisms like protozoa and algae. The fascinating fact Adorna discovered from the study is that an individual can examine freshwater microorganisms even though access to a reservoir is difficult.

### ***Foldscope for Biological Research***

Foldscope is capable of using for biological research. In the study conducted by Denaro et al. (2018), the researchers specifically observed the salivary glands, intestine cells, and neural cells. The conclusion was that Foldscope could be used to observe the number, alterations, and even nuclei of a cell. Hematoxylin and eosin stain was used in the experiment. The staining technique was vital to observe the specimen with significant clarity. The researchers stated explicitly about the viewing method of the Foldscope and possible alteration for innovation.

### ***Shortcomings of Educational System***

The study conducted by De Beer et al. (2020) is qualitative approach research about teachers' and students' perspective in using the Foldscope as part of "frugal" or affordable science. Teachers from the study planned a water quality assessment for the students to simulate classroom action research. Classroom action research aims to know the best condition or process for the classroom. The researchers then gathered the data. Then, identified the factors that inhibit or promote Foldscope. The teachers and students showed



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an insignificant performance due to unfamiliarity with the strategy. Some of the learners from the sample of the study found the activity enjoyable. The researchers concluded that the current educational system does not promote self-discovery, although it is proven effective. The study suggests providing alternative strategies to simulate classroom action research for effective learning.

### ***Foldscope in Microbiology***

The management of biofilm-related health problems is becoming difficult. *Pseudomonas aeruginosa*, an invasive Gram-negative pathogen, can make a biofilm. A few vitro techniques are possible for the early identification of biofilm development. Involves advanced instrumentation knowledge and sometimes not beyond the reach of a variety of resources in limited conditions. The use of a cost-efficient, easy-to-use origami-based microscope, Foldscope, for direct analysis of biofilm was an effective method for detecting biofilms in *Pseudomonas aeruginosa*. The Foldscope has been transformed into a fluorescence microscope with the help of blue light and filters. The use of a simple and precise tool in the format of a fluorescence Foldscope could be sufficient to detect biofilms including in resource-limited environments. The study revealed that the fluorescence Foldscope could be an accurate instrument for analyzing biofilm formation in *Pseudomonas aeruginosa* isolates (Deshamukhya et al., 2020).

### ***Foldscope in Cervical Cytology***

With the lowered cost of microscope imagery in previous years, poorly developed countries always lack the financial means to use these innovations. Smartphones have undergone remarkable technical adaptation, including attached microscope lenses.



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Smartphone cameras, which increase the image's magnification, can compete with traditional laboratory microscopes at a lower price. These innovations can provide a relatively cost-effective approach to the issues of microscopic imaging in developing countries. Cervical cancer remains a public health issue in rural parts of developed countries. Thorough knowledge of the history of human papillomavirus (HPV) infection and associated cervical neoplasm has contributed to the hunt for biomarkers to enhance the mechanism of cervical cancer testing. Affordable and efficient microscope imaging equipment can influence the diagnosis in areas where testing labs are low. Foldscope provides a low-cost way to diagnose cervical cytology. The Foldscope in cervical cytology shows that it has a strong alignment with traditional microscopy. Its use may enhance cytological understanding in remote communities and improve the efficiency of cervical cancer treatment (Naqvi et al., 2020).

### ***Foldscope as Exploratory Educational Tool***

In the study conducted by Mohan et al. (2020), Foldscope was evaluated as an educational tool for different specific topics in microscopy. The researchers observed cheek cells with methylene blue stain and acetocarmine stain with Foldscope. Then, researchers compared Foldscope and light microscope in detecting micronucleus. A light microscope with a 100x magnification lens can observe the micronucleus. However, Foldscope with 140x magnification only cannot observe the micronucleus. The capability of Foldscope was only the magnification of the scanning lens for the light microscope. The researchers also tried to observe a blood specimen under the Foldscope. Then, researchers observed both red blood cells and leucocytes with a field stain on the specimen. Based on



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the observations in the study, the Foldscope was significant in using as an educational tool. The cost-effectiveness of the tool was highly dominated by the portability and viewing features. Foldscope promotes virtual microscopy and could become an innovation to the traditional learning method. The researchers also added possible improvisation for the tool for more image-taking stability.

### ***Feasibility of Foldscope***

In the study conducted by Waliullah (2018), Foldscope was tested in blood cell counting. The researcher concluded that Foldscope is easy to use in terms of blood histology. With the help of a smartphone, Foldscope is significantly feasible in cell counting and morphology analysis. Smart devices can also be used to document the findings and upgrade the magnification. On the other hand, the images captured were blurry due to the maximum magnification provided by the smartphone. The study suggests developing automated algorithms, mobile phone-based applications that can be used in the medical field.

### ***Shortcomings in Laboratory***

The researchers assess the readiness of the science laboratories in school for junior high school students. The study was conducted in two different schools from Lanao Del Sur, Philippines. In terms of apparatus quantity, both of the schools did not have enough. Specifically, one school had three microscopes only, while the other had twenty microscopes. The researchers also found that the schools lacked laboratory room, defective laboratory equipment, lack of teacher training in using science equipment, and lack of



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science teaching training. According to the K-12 curriculum of the country, science education should be practical and features hands-on activities. In the recommendation section, the researchers address the problems. The researchers suggest providing adequate laboratory facilities and equipment. Teachers should also have the proper training to use the apparatuses to teach science subjects effectively. With the help of seminars, the researchers believed that teachers could acquire knowledge to develop scientific thinking (Hadji Abas, 2020).

### **Synthesis of Reviewed Related Literature and Studies**

Barker (2019) and O'brien (2015) discussed Foldscope's significant features, such as accessibility, durability, and portability. The three features that determined usability were considered as the independent variables of the study. On the other hand, Prakash (2018), Gubbi Labs (2019), and Waliullah (2018) discussed the feasibility of Foldscope. The authors provided information on how the users can accept Foldscope alongside the mission of frugal science. Denaro et al. (2018), Deshamukhya et al. (2020), Naqvi et al. (2020), and Adorna (2020) further discussed the use and effectiveness of Foldscope in different domains that it could be an alternative microscope. The authors found the disadvantages and advantages of the tool in terms of usage.

Robinson (2016), De Beer et al. (2020), and Hadji Abas et al. (2020) discussed the shortcomings in the current educational system. On the other hand, Budich (2016), Chew (2018), KIDS Club Philippines (2016), Mohan et al. (2020), and Wittenburg and Osborne (2021) discussed Foldscope in the context of learning and provided the perspectives of the learners in using it.



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### **Gaps Bridged by the Present Study**

After a thorough review of the related literature and studies, it was observed that the studies discussed the use of alternative microscopes showed significant positive responses in varying domains. Most of the studies conducted focused mainly on the usability of alternative microscopes in a foreign setting, and few are only conducted in a local setting. To address the existing gap, fill in the blind spot, and provide an in-depth understanding of the phenomenon, the researchers focused on the feasibility of a particular product called Foldscope as an alternative microscope alongside its accessibility, durability, and portability of use and conducted in a local setting. The study was done through quantitative surveys and in-depth study of the student's perception of the use of the said product.





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### **Chapter 3**

#### **RESEARCH METHODOLOGY**

The chapter presented the discussion on the research design, sources of data, the population of the study, instrumentation and validation, evaluation and scoring, data gathering procedure, treatment and analysis of data, and ethical consideration.

##### **Research Design**

The study employed a quantitative non-experimental correlational research design. According to Curtiz et al. (2015), correlational research was essential in determining the relationship between two or more variables. It primarily focused on correlating the two variables with the use of appropriate correlational statistical treatment. This research was conducted to determine if there is a significant relationship between Foldscope's usability and feasibility.

##### **Sources of Data**

The primary and secondary sources were drawn by obtaining the essential data needed in this research. The primary source of data was the respondents who answered the survey questionnaire. Secondary sources include books, online journals, periodicals, and other references that the researcher consulted and cited in the review of related literature.

##### **Population of the Study**

The respondents of the study consisted of sixty (60) senior high school students taking up the Science, Technology, Engineering, and Mathematics (STEM) strand for this School Year 2020-2021 at the Lake Shore Educational Institution.



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### **Sampling Technique**

The students were selected using the purposive quota sampling technique in which the possible respondents should fit into the criteria set by the researchers, which were: 1.) senior high students under STEM strand; 2.) had background experience on the use of the conventional microscope; and 3.) currently enrolled this school year. According to Galloway (2005), purposive sampling endeavors to direct a study to a range of respondents who are ultimately representative of at least the extremes of variables under consideration.

Furthermore, the researchers employed availability sampling. According to Ochoa (2017), availability sampling involves selecting a sample from the population because it is accessible; meaning, individuals are selected for the research not because they meet some statistical criterion but because they are readily available. Given the situation that the study was conducted in the midst of a pandemic and respondents had the chance to be part of the study based on their available time.

### **Instrumentation and Validation**

In gathering data, the researchers utilized a closed questionnaire through Google Forms in which the respondents selected their answers to questions by ticking or clicking their responses. The questionnaire was divided into two parts: Scale 1 covered the level of usability of Foldscope in terms of accessibility, durability, and portability. Scale 2 covered the level of feasibility of Foldscope as an alternative microscope in terms of operational and technical feasibility.



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The research instrument was presented to the research adviser for initial checking. For further validation, the researchers consulted experts in the field of language, statistics, and research, which provided comments and possible recommendations.

Reliability is ensured through pilot testing, to be conducted on thirty (30) students with similar qualifications as those of the actual respondents. The survey questionnaire is assessed using Cronbach's alpha to determine the internal consistency of the items. After the pilot test and tallying, the instrument obtained the following Cronbach Alpha result: On one hand, the level of usability of Foldscope in terms of accessibility (0.803), durability (0.824), and portability (0.949). On the other hand, the level feasibility of Foldscope as an alternative microscope in terms of operational (0.949) and technical (0.911) feasibility obtained the said result respectively.



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### Evaluation and Scoring

To measure the level of usability of Foldscope, the following numerical rating, numerical range, categorical response, verbal interpretation, and verbal description were used:

<b>Numerical Rating</b>	<b>Numerical Range</b>	<b>Categorical Response</b>	<b>Verbal Interpretation</b>	<b>Verbal Transcription</b>
4	3.26 - 4.00	Strongly Agree (SA)	Highly Functional	The respondent experienced the indicator 76-100% of the time.
3	2.51 - 3.25	Agree (A)	Functional	The respondent experienced the indicator 51-75% of the time.
2	1.76 - 2.50	Disagree (D)	Less Functional	The respondent experienced the indicator 26-50% of the time.
1	1.00 - 1.75	Strongly Disagree (SD)	Least Functional	The respondent experienced the indicator 1-25% of the time.



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To measure the level of feasibility of Foldscope as an alternative, the following numerical rating, numerical range, categorical response, verbal interpretation, and verbal description were used:

<b>Numerical Rating</b>	<b>Numerical Range</b>	<b>Categorical Response</b>	<b>Verbal Interpretation</b>	<b>Verbal Transcription</b>
4	3.26 - 4.00	Strongly Agree (SA)	Highly Feasible	The respondent experienced the indicator 76-100% of the time.
3	2.51 - 3.25	Agree (A)	Feasible	The respondent experienced the indicator 51-75% of the time.
2	1.76 - 2.50	Disagree (D)	Less Feasible	The respondent experienced the indicator 26-50% of the time.
1	1.00 - 1.75	Strongly Disagree (SD)	Least Feasible	The respondent experienced the indicator 1-25% of the time.

### Data Gathering Procedure

After the validation of the instrument, the researchers secured consent from the Office of the Principal to conduct the study. Coordination was done among the teachers, researchers, and respondents. Once the respondents agreed, the virtual demonstration of Foldscope was conducted to the respondents. Then, the questionnaire was produced through Google Forms, forwarded the link of the online survey questionnaire to the respondents, and retrieved. The data gathered were organized, tallied, and were subjected to statistical analysis.



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### **Treatment and Analysis of Data**

Once the survey questionnaire had been completed by the respondents, data were tabulated and subjected to the following statistical tools:

- 1) Weighted Mean and Ranking were used to determine:
  - a) the level of usability and,
  - b) the level of feasibility of Foldscope as an alternative microscope.
- 2) Pearson Correlation Coefficient was used to determine the relationship between the Foldscope's level of usability and feasibility as an alternative microscope.

### **Ethical Consideration**

The researchers completed this study bearing in mind the ethical considerations, especially in observing confidentiality, quality, and human subject protection. Permission was first sought from the office of the Principal of the Lake Shore Educational Institution, where the researchers conducted the study. Since some of the respondents were minors, parental approval was obtained as part of the consent form to be secured explaining their right to withdraw from the study at any time voluntarily, the central purpose of the study, the procedures used in the data collection, comments about protecting confidentiality, the statement about known risks associated with, and the expected benefits to accrue by participating in the study.



## Chapter 4

### PRESENTATION, ANALYSIS, AND INTERPRETATION OF DATA

This chapter presented the quantitative data gathered with the corresponding interpretation and analysis.

#### 1. What is the level of usability of Foldscope as an alternative microscope in terms of:

##### 1.1. accessibility;

**Table 1**  
**Foldscope's Level of Usability as an Alternative Microscope: Accessibility**

Indicators	Weighted Mean	Verbal Interpretation	Rank
1. I think I can easily find Foldscope in an online store.	3.25	Functional	3
2. I think Foldscope has a reasonable price. (₱200 - ₱300)	3.28	Highly Functional	2
3. I think I can buy Foldscope anytime.	2.88	Functional	5
4. I think Foldscope is applicable in rural areas.	3.23	Functional	4
5 I think Foldscope can be accessible for students.	3.40	Highly Functional	1
<b>Summative Mean</b>	<b>3.21</b>	<b>Functional</b>	

Table 1 showed the level of usability of Foldscope as an alternative microscope in terms of accessibility. Indicator 5, with a statement of "I think Foldscope can be accessible for students," had the highest weighted mean of 3.40, which was interpreted as Highly Functional. On the other hand, Indicator 3, with a statement of "I think I can buy Foldscope anytime," had the lowest mean of 2.88, which was interpreted as Functional. To sum it up, a summative mean of 3.21 was interpreted as Functional. The results indicated that Foldscope as an alternative microscope was perceived as accessible by the students.



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The findings of the study agreed with the statement of Barker (2018), which argues that the materials used in Foldscope make it more cost-effective and accessible for everyone. The results also agreed with the statement of Chew (2018) and Prakash (2018), which argues that Foldscope can accomplish the mission of its creators to develop scientific knowledge for students in poor-resource areas. Apparatuses such as Foldscope became accessible because it does not stimulate cost-barrier. In consonance with the result, according to Naqvi et al. (2020), poorly developed countries took advantage of low-cost alternative tools such as Foldscope to use in research. The capability of Foldscope is also significant compared to a conventional microscope.

### 1.2. durability; and,

**Table 2**  
**Foldscope's Level of Usability as an Alternative Microscope: Durability**

<b>Indicators</b>	<b>Weighted Mean</b>	<b>Verbal Interpretation</b>	<b>Rank</b>
1. I think Foldscope is long-lasting.	3.25	Functional	2
2. I think Foldscope is water-resistant.	3.32	Highly Functional	1
3. I think Foldscope is tear-resistant.	3.05	Functional	5
4. I think the materials composing the Foldscope are durable.	3.28	Highly Functional	3.5
5. I think Foldscope is firmly fixed but flexible.	3.28	Highly Functional	3.5
<b>Summative Mean</b>	<b>3.24</b>	<b>Functional</b>	

Table 2 showed the level of usability of Foldscope as an alternative microscope in terms of durability. Indicator 2, with a statement of "I think Foldscope is water-resistant," had the highest weighted mean of 3.32, which was interpreted as Highly Functional.





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However, Indicator 3, with a statement of "I think Foldscope is tear-resistant," had the lowest mean of 3.05, which was interpreted as Functional. To sum it up, a summative mean of 3.24 was interpreted as Functional. The results indicated that Foldscope as an alternative microscope was perceived as durable by the students.

The findings of the study agreed with the statement of O'brien (2015), which argues that Foldscope can withstand damages. Foldscope had a significant advantage in durability compared to a conventional microscope. In addition, in the activity conducted by KIDS Club Philippines (2016), children used Foldscope to determine different specimens. Children do not have to worry about the risks of damaging the tool. Its durability makes it more usable in practical use by experts and students at any age.

### 1.3. portability?

**Table 3**  
**Foldscope's Level of Usability as an Alternative Microscope: Portability**

Indicators	Weighted Mean	Verbal Interpretation	Rank
1. I think the size makes Foldscope portable.	3.45	Highly Functional	1.5
2. I think the weight makes Foldscope portable.	3.40	Highly Functional	5
3. I think I can put Foldscope in a small bag.	3.43	Highly Functional	3
4. I think I can easily handle Foldscope.	3.42	Highly Functional	4
5. I think I can bring Foldscope to outdoor places.	3.45	Highly Functional	1.5
<b>Summative Mean</b>	<b>3.43</b>	<b>Highly Functional</b>	

Table 3 showed the level of usability of Foldscope as an alternative microscope in terms of portability. Indicators 1 and 5, with a statement of "I think the weight makes



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Foldscope portable" and "I think I can bring Foldscope to outdoor places," had the highest weighted mean of 3.45, which were interpreted as Highly Functional. On the other hand, Indicator 2, with a statement of "I think the weight makes Foldscope portable," had the lowest mean of 3.40, which was interpreted as Highly Functional. To sum it up, a summative mean of 3.43 was interpreted as Highly Functional. The results indicated that Foldscope as an alternative microscope was perceived as very portable by the students.

The findings of the study agreed with the statements of O'brien (2015) and Gubbi Labs (2019), which argues that Foldscope is capable of outdoor use in terms of its weight and size. Field researchers already tested the portability of Foldscope and concluded that it is a significant advantage compared to a conventional microscope. The results were also in line with Gubbi Labs' (2019) statement, which argues that Foldscope is portable in terms of weight compared to a conventional microscope. Gubbi Labs also conduct workshops in different locations, including rural areas with Foldscope. They teach individuals interested in science to use Foldscope to explore nature.

**Table 4**  
**Summative Table of Foldscope's Level of Usability as an Alternative Microscope**

<b>Indicators</b>	<b>Weighted Mean</b>	<b>Verbal Interpretation</b>	<b>Rank</b>
<b>Accessibility</b>	3.21	Functional	3
<b>Durability</b>	3.24	Functional	2
<b>Portability</b>	3.43	Highly Functional	1
<b>Overall Summative Mean</b>	<b>3.29</b>	<b>Highly Functional</b>	



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Table 4 showed the summative table of the level of usability of Foldscope as an alternative microscope. Portability had the highest summative mean of 3.43, which was interpreted as Highly Functional. Next, durability had the second-highest summative mean of 3.24, which was interpreted as Functional. On the other hand, accessibility had the lowest summative mean of 3.21, which was interpreted as Functional. In conclusion, accessibility, durability, and portability had an overall summative mean of 3.29, which was interpreted as Highly Functional. The results indicated that Foldscope was perceived as highly functional by the students in terms of accessibility, durability, and portability.

The findings of the study agreed with the statement of Prakash (2018), which argues that Foldscope elaborates "frugal" science, and everyone should have it. Foldscope is usable because it is accessible, portable, and durable. The results of the study promote a solution to the problem stated by Hadji Abas (2020), which argues that there is an insignificant amount of science equipment and laboratory. Educational institutions can promote the use of accessible, durable, and portable tools such as Foldscope. Foldscope is economical that almost everyone can afford. It can also be contained anywhere and can be used anytime and anywhere.

## **2. What is the level of feasibility of Foldscope as an alternative microscope in terms of:**

### **2.1. operational feasibility; and,**



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**Table 5**  
**Foldscope's Level of Feasibility as an Alternative Microscope: Operational Feasibility**

Indicators	Weighted Mean	Verbal Interpretation	Rank
1. I think Foldscope's eye-viewing method is easy.	3.18	Feasible	7
2. I think Foldscope's smart-viewing method is easy.	3.25	Feasible	4
3. I think moving and scanning the slide is easy.	3.10	Feasible	8
4. I think focusing on the view is easy.	3.03	Feasible	10
5. I think paper slide is an effective alternative for glass slide.	3.07	Feasible	9
6. I think the live view of a specimen can be documented easily.	3.20	Feasible	6
7. I think the magnification of Foldscope is significant for learning.	3.32	Highly Feasible	2.5
8. I think the magnification of Foldscope with a smart device attached is significant for learning.	3.32	Highly Feasible	2.5
9. I think the magnets and phone coupler (magnet attached to a smart device) made Foldscope easy to use.	3.22	Feasible	5
10. I think that the effectiveness of Foldscope is reasonable for its cost.	3.37	Highly Feasible	1
<b>Summative Mean</b>	<b>3.21</b>	<b>Feasible</b>	

Table 5 showed the level of feasibility of Foldscope as an alternative microscope in terms of operational feasibility. Indicator 10, with a statement of "I think that the effectiveness of Foldscope is reasonable for its cost," had the highest weighted mean of 3.37, which was interpreted as Highly Feasible. However, Indicator 4, with a statement of "I think focusing on the view is easy," had the lowest mean of 3.03, which was interpreted as Feasible. To sum it up, a summative mean of 3.21 was interpreted as Feasible. The results indicated that Foldscope in terms of its operational feasibility as an alternative microscope was perceived as easy to be used by the students.



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The findings of the study were related to the study conducted by Waliullah (2018), which argues that Foldscope is easy to use in studying blood histology. The researcher states that the attachment of smart devices to Foldscope is very significant and suggests developing mobile-based applications for the medical field. The results were also related to the study conducted by Deshamukhya et al. (2020), which argues that Foldscope is cost-efficient, provides accurate observations, and is easy for analyzing biofilm formation. Staining techniques and attachments can improve the capability of Foldscope.

### 2.2. technical feasibility?

**Table 6**  
**Foldscope's Level of Feasibility as an Alternative Microscope: Technical Feasibility**

<b>Indicators</b>	<b>Weighted Mean</b>	<b>Verbal Interpretation</b>	<b>Rank</b>
1. I think Foldscope can provide significant hands-on experience for students.	3.33	Highly Feasible	3
2. I think Foldscope can be used for exploratory learning.	3.32	Highly Feasible	4
3. I think Foldscope can stimulate interest for students.	3.47	Highly Feasible	2
4. I think Foldscope can be used in face-to-face classes with live instructions.	3.53	Highly Feasible	1
5. I think Foldscope can be used in virtual classes with remote instructions.	3.17	Feasible	5
<b>Summative Mean</b>	<b>3.36</b>	<b>Highly Feasible</b>	

Table 6 showed the level of feasibility of Foldscope as an alternative microscope in terms of technical feasibility. Indicator 4, with a statement of "I think Foldscope can be used in face-to-face classes with live instructions," had the highest weighted mean of 3.53, which was interpreted as Highly Feasible. Indicator 5, with a statement of " I think Foldscope can be used in virtual classes with remote instructions.," had the lowest mean of



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3.17, which was interpreted as Feasible. To sum it up, a summative mean of 3.36 was interpreted as Feasible. The results indicated that Foldscope, in terms of its technical feasibility as an alternative microscope was perceived as highly applicable for a significant learning experience by the students.

The findings of the study agreed with the statement of Wittenburg and Osborne (2021), which argues that Foldscope is significant for learning and for virtual participation. Foldscope is capable of sharing observations virtually and reporting remotely. It can also provide hands-on learning to provide quality education. The results of the study are also related to the study conducted by De Beer et al. (2020) which argues that students appreciate hands-on activities. Although the current educational system does not promote self-discovery, providing alternative strategies or innovations to traditional learning methods using accessible tools such as Foldscope is possible.

**Table 7**

**Summative Table of Foldscope's Level of Feasibility as an Alternative Microscope**

<b>Indicators</b>	<b>Weighted Mean</b>	<b>Verbal Interpretation</b>	<b>Rank</b>
<b>Operational Feasibility</b>	3.21	Feasible	2
<b>Technical Feasibility</b>	3.36	Highly Feasible	1
<b>Overall Summative Mean</b>	<b>3.29</b>	<b>Highly Feasible</b>	

Table 7 showed the level of feasibility of Foldscope as an alternative microscope in terms of operational and technical feasibility. Technical feasibility with a mean of 3.36, which was interpreted as Feasible, was higher than operational feasibility with a mean of



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3.21, which was interpreted as Highly Feasible. In conclusion, operational and technical feasibility had an overall summative mean of 3.29, which was interpreted as Highly Feasible. The results indicated that Foldscope was perceived as highly feasible in terms of operational and technical feasibility by the students.

The findings of the study agreed with the statement of Prakash (2018), which argues that the mechanism of Foldscope is easy to understand and also applicable for stimulating curiosity for the learners. According to the preconceived opinion of the respondents, Foldscope is easy to use and applicable for students. It was also related to the study conducted by Mohan et al. (2020), which argues that Foldscope meets the capability of a microscope essential for exploratory learning. It was said that Foldscope promotes virtual microscopes and innovates traditional learning methods.

### **3. Is there a significant relationship between the level of usability and feasibility of Foldscope as an alternative microscope?**

**Table 8**  
**Relationship between the Level of Usability and Feasibility of Foldscope as an Alternative Microscope**

<b>Variables</b>	<b>Treatment</b>	<b>Result</b>	<b>Interpretation</b>
Usability and Feasibility	Pearson-R	$r = 0.905$ $p\text{-value} = 0.000$	Strongly Positive Significant**

**\*\*level of significance @0.05**

Table 8 showed the relationship between the level of usability and feasibility of Foldscope as an alternative microscope. With an r-value of .905 and a p-value of 0.000, which was lower than the level of significance, the two variables showed a strong positive



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correlation. Therefore, as the product's level of usability was being achieved, and so is its feasibility to be used as an alternative to the original apparatus.

The study's findings agreed with the statement of Robinson (2016), which argues that microscopy is essential and should promote Foldscope to be used in education to encourage individuals to appreciate science. It is usable because it does not require laboratory facilities. It is feasible in terms of usage because it is easy and practical to use. The results were also related to the statement of Barker (2018) and O'brien (2015), which argues that Foldscope is usable in terms of accessibility, durability, portability. In addition, the statements of Wittenburg and Osborne (2021) and Waliullah (2018) agreed to the results. The authors argued that Foldscope is significantly acceptable in terms of usage for learning. According to KIDS Club Philippines (2016), it was also tested by children and by interested individuals as conducted by Adorna (2020).

As the problem proposed by Robinson (2019), De Beer et al. (2020), and Hadji Abas et al. (2020) about the shortage of apparatuses essential for learning, usable and feasible tools such as Foldscope can become an alternative learning microscopy tool for students according to the results of this study.





## **Chapter 5**

### **SUMMARY OF FINDINGS, CONCLUSIONS, AND FUTURE DIRECTIONS**

This chapter presented the summary of findings based on the data gathered from the study, the conclusions drawn, and the future direction offered by the researchers.

This study employed a correlational research design to determine the significant relationship between the level of usability and feasibility of Foldscope as an alternative microscope. It aimed to answer the following questions:

1. What is the level of usability of Foldscope as an alternative microscope in terms of:
  - 1.1. accessibility;
  - 1.2. durability; and,
  - 1.3. portability?
2. What is the level of feasibility of Foldscope as an alternative microscope in terms of:
  - 2.1. operational feasibility; and,
  - 2.2. technical feasibility?
3. Is there a significant relationship between the level of usability and feasibility of Foldscope as an alternative microscope?



## **Summary of Findings**

The following were the summary of findings based on the data gathered:

### **1. As to the level of usability of Foldscope as an alternative microscope**

The level of usability of Foldscope as an alternative microscope in terms of portability had the highest summative mean of 3.43, followed closely by durability with a summative mean of 3.24. Accessibility ranked third with a summative mean of 3.21. Overall, the level of usability of Foldscope had a 3.29 summative mean, which was interpreted as Highly Functional.

### **2. As to the level of feasibility of Foldscope as an alternative microscope**

The level of feasibility of Foldscope as an alternative microscope in terms of technical feasibility had a higher summative mean of 3.36 than the operational feasibility with a summative mean of 3.21. Overall, the level of feasibility of Foldscope had a 3.29 summative mean, which was interpreted as Highly Feasible.

### **3. As to the significant relationship between the level of usability and feasibility of Foldscope as an alternative microscope.**

The r-value of .905 and p-value of 0.000 revealed that a significant relationship existed between the level of usability and feasibility of Foldscope as an alternative microscope.



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### Conclusion

Based on the findings of the study, the following conclusions were drawn:

1. Foldscope as an alternative microscope is highly functional according to the perception of students to the virtual demonstration.
2. Foldscope as an alternative microscope is highly feasible according to the perception of students to the virtual demonstration.
3. The Foldscope's level of usability has a strong positive correlation to its level of feasibility. It means that as the alternative product meet its usability on the part of the user, its feasibility to be used as an alternative apparatus is also accepted. Therefore, the null hypothesis is rejected.

### Future Directions

Based on the findings of the study, the following future directions were offered:

1. Educational institutions or organizations should promote Foldscope to students who do not have access to conventional light microscope and laboratories and manufacture locally to reduce the selling price.
2. Biology teachers should use Foldscope in creating their lesson plans to promote self-discovery learning for students anytime a conventional light microscope is not available.
3. Future researchers should conduct a study correlating the Foldscope's usability and feasibility in various domains with an actual hands-on assessment of the Foldscope and broaden the scope of target respondents.



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## Appendix A: Survey Questionnaire

To the respondent,

We are currently conducting our research entitled "Perception on the Use of Foldscope as an Alternative Conventional Microscope" as partial fulfillment of our course requirements for the subject, Practical Research 2 at Lake Shore Educational Institution. In light of this, we humbly request time and effort to go over this questionnaire as your responses will help achieve our research's purpose. As part of ethical consideration, the information you will provide will be kept confidential and used for research purposes only. Thank you!

Kyle Carlo C. Lasala  
 Researcher / Group Leader

Name of the Respondent (optional): \_\_\_\_\_

Part I. Direction: The statements below determine Foldscope's usability in terms of accessibility, durability, and portability. Kindly put a checkmark (✓) in the column corresponding to your opinion based on Foldscope's live demonstration.

<b>FACTORS</b>	Strongly Disagree	Disagree	Agree	Strongly Agree
<b>A. Accessibility</b>				
1. I think I can easily find Foldscope in an online store.				
2. I think Foldscope has a reasonable price. (₱200 - ₱300)				
3. I think I can buy Foldscope anytime.				
4. I think Foldscope is applicable in rural areas.				
5. I think Foldscope can be accessible for students.				
<b>B. Durability</b>				
1. I think Foldscope is long-lasting				
2. I think Foldscope is water-resistant.				
3. I think Foldscope is tear-resistant.				



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4. I think the materials composing the Foldscope are durable.				
5. I think Foldscope is firmly fixed but flexible.				
<b>C. Portability</b>				
1. I think the size makes Foldscope portable.				
2. I think the weight makes Foldscope portable.				
3. I think I can put Foldscope in a small bag.				
4. I think I can easily handle Foldscope.				
5. I think I can bring Foldscope to outdoor places.				

Part II. Direction: The statements below determine Foldscope's feasibility to become an alternative conventional learning context tool. Kindly put a checkmark (✓) in the column corresponding to your opinion based on Foldscope's live demonstration.

<b>FACTORS</b>	Strongly Disagree	Disagree	Agree	Strongly Agree
<b>A. Operational Feasibility</b>				
1. I think Foldscope's eye-viewing method is easy.				
2. I think Foldscope's smart-viewing method is easy.				
3. I think moving and scanning the slide is easy.				
4. I think focusing on the view is easy.				
5. I think paper slide is an effective alternative for glass slide.				
6. I think the live view of a specimen can be documented easily.				
7. I think the magnification of Foldscope is significant for learning.				
8. I think the magnification of Foldscope with a smart device attached is significant for learning.				





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9. I think the magnets and phone coupler (magnet attached to a smart device) made Foldscope easy to use.				
10. I think that the effectiveness of Foldscope is reasonable for its cost.				
<b>B. Technical Feasibility</b>				
11. I think Foldscope can provide significant hands-on experience for students.				
12. I think Foldscope can be used for exploratory learning.				
13. I think Foldscope can stimulate interest for students.				
14. I think Foldscope can be used in face-to-face classes with live instructions.				
15. I think Foldscope can be used in virtual classes with remote instructions.				



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### Appendix B: Communication Letter

April 15, 2021

Dr. Yolanda V. Gilbuena  
Principal  
Lake Shore Educational Institution  
A. Bonifacio St., Canlalay  
Biñan City, Laguna

Dear Dr. Gilbuena,

Good day! We, the research group of grade 12 STEM, are currently doing our research entitled "Perception on the Use of Foldscope as an Alternative Conventional Microscope" as a course requirement in Research in Daily Life 2. The research will be significant to the institution if appropriately conducted. It generally aims to provide quality education amidst the pandemic and establish a scientific community.

As part of our research process, we request your permission to conduct an online survey of 60 STEM respondents from grades 11 and 12. The researchers will make ethical considerations.

We are hoping for your positive response from your kind office. Thank you, God bless us all!

Respectfully yours,

Kyle Carlo C. Lasala  
Giuliana Maria R. Bautista  
Louisse E.J. A. Magbitang  
Kate Camille R. Cortez  
Kingsley S. Almeda  
Christian Ashley D. Quimzon

Noted by:

Ms. Michelle Ann T. Guico  
Subject Teacher & SHS Coordinator

Approved by:

Dr. Yolanda V. Gilbuena  
School Principal



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### Appendix C

#### Language Editor's Certification

This is to certify that this thesis entitled "**Perception on the Use of Foldscope as an Alternative Conventional Microscope**" prepared and submitted by **Kingsley S. Almeda, Giuliana Maria R. Bautista, Kate Camille R. Cortez, Kyle Carlo C. Lasala, Lousse E.J. A. Magbitang and Christian Ashley D. Quimzon** has been edited by the undersigned.

**Garry C. Bayran, LPT**  
*Language Editor*



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### Appendix D

#### Statistician's Certification

This is to certify that this thesis entitled "**Perception on the Use of Foldscope as an Alternative Conventional Microscope,**" prepared and submitted by **Kyle Carlo C. Lasala, Kingsley S. Almeda, Giuliana Maria R. Bautista, Kate Camille R. Cortez, Lousse E.J. A. Magbitang, and Christian Ashley D. Quimzon,** has been statistically reviewed by the undersigned.

**Jonathan M. Salamo, LPT**  
*Statistician*



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### Appendix E: Curriculum Vitae

**Name:** Kingsley S. Almeda

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Biñan City, Laguna

**Contact Number:** N/A

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### Educational Attainment

**Grade School:** Dela Paz Elementary School

**Junior High School:** Lake Shore Educational Institution

**Senior High School:** Lake Shore Educational Institution

### Personal Data:

**Height** : 175 cm  
**Weight** : 57 kg  
**Birthdate** : December 8, 2002  
**Age** : 18  
**Birthplace** : Biñan City, Laguna  
**Citizenship** : Filipino  
**Religion** : Roman Catholic  
**Father's Name** : Romeo E. Almeda  
**Mother's Name** : Aurea S. Almeda

Kingsley S. Almeda

Signature over Printed Name



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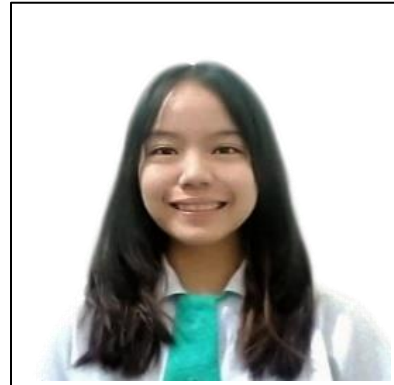
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### Educational Attainment

**Grade School:** Malaban Elementary School

**Junior High School:** Lake Shore Educational Institution

**Senior High School:** Lake Shore Educational Institution

### Personal Data:

**Height** : 151 cm

**Weight** : 38kg

**Birthdate** : July 10, 2003

**Age** : 17

**Birthplace** : FCH San Pedro, Laguna

**Citizenship** : Filipino

**Religion** : Roman Catholic

**Father's Name** : Arsenio A. Bautista

**Mother's Name** : Maria Luisa R. Bautista

Giuliana Maria R. Bautista

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### Educational Attainment

**Grade School:** Biñan Elementary School

**Junior High School:** Lake Shore Educational Institution

**Senior High School:** Lake Shore Educational Institution

### Personal Data:

**Height** : 164 cm  
**Weight** : 49 kg  
**Birthdate** : September 6, 2002  
**Age** : 18  
**Birthplace** : Muntinlupa City  
**Citizenship** : Filipino  
**Religion** : Roman Catholic  
**Father's Name** : Francisco S. Cortez Jr.  
**Mother's Name** : Catherine R. Cortez

Kate Camille R. Cortez

**Signature over Printed Name**



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### Educational Attainment

**Grade School:** Panorama Montessori School Inc.

**Junior High School:** Lake Shore Educational Institution

**Senior High School:** Lake Shore Educational Institution

### Personal Data:

**Height** : 178 cm  
**Weight** : 50 kg  
**Birthdate** : October 29, 2002  
**Age** : 18  
**Birthplace** : Quezon City  
**Citizenship** : Filipino  
**Religion** : Jehovah's Witness  
**Father's Name** : Ronelo R. Lasala  
**Mother's Name** : Carol Jean C. Lasala

Kyle Carlo C. Lasala

**Signature over Printed Name**





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### **Educational Attainment**

**Grade School:** Pedro Escueta Memorial School

**Junior High School:** Lake Shore Educational Institution

**Senior High School:** Lake Shore Educational Institution

### **Personal Data:**

**Height** : 150 cm

**Weight** : 48 kg

**Birthdate** : April 15 2003

**Age** : 18

**Birthplace** : Biñan City, Laguna

**Citizenship** : Filipino

**Religion** : MCGI

**Father's Name** : Lauro S. Magbitang Jr

**Mother's Name** : Erma A. Magbitag

Louisse E.J. A. Magbitang  
**Signature over Printed Name**



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### Educational Attainment

**Grade School:** Canlalay Elementary School

**Junior High School:** Lake Shore Educational Institution

**Senior High School:** Lake Shore Educational Institution

### Personal Data:

**Height** : 162 cm

**Weight** : 98 kg

**Birthdate** : April 18, 2003

**Age** : 18

**Birthplace** : Rizal Medical Center, Pasig City

**Citizenship** : Filipino

**Religion** : Roman Catholic

**Father's Name** : Ferdie P. Quimzon

**Mother's Name** : Margie D. Quimzon

  
Christian Ashley D. Quimzon

Signature over Printed Name