RESEARCH PROPOSAL
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2016-2017

Title: Creating Cheap, High-Powered, Do-It-Yourself Microscopes: Curing PDMS Lens and Making Simple Microscopes

Introduction & Overview of Research:

This project will focus on creating cheaper, high-powered, simple-to-make microscopes, including the lens of the microscopes. The lens, made of a polymer called PDMS (polydimethylsiloxane) will be cured, and the microscope assembled from commonly used materials. By creating these more efficient microscopes at a lower cost, these microscopes will be more widely accessible to all people, especially to poorer, less scientifically literate areas.

Background & Rationale:

Ever since the time of the Romans, humans have discovered that certain shapes of glass had properties which could magnify objects (Vandervoort). Since then microscopes have been invented and evolved at an incredible rate. Microscopy is the science which seeks to see magnified and clear images of microscopic objects. The most commonly used microscope, the light microscope, produces magnified images by refracting, or bending and focusing light through lens, through the object, the objective, the eyepiece, and finally to the human eye. The image is inverted and magnified (Vandervoort).

One of the most important components of the microscope is the lens or series of lens which magnify and cast a clear, microscopic image of a specimen or object. Although glass and other fiber-optics are often used as components for the lens, polymers can also be used. For instance, in this experiment, the polymer, PDMS (polydimethylsiloxane) will be cured to create lens, molded into a desirable shape. By curing PDMS, various monomers of PDMS cross-link to create an intricate web of PDMS (Lee et al). Some benefits of PDMS include high flexibility, adaptability, as well as breathability (Dow Corning), as well as having high performance, transparency, durability, and being easy to make (Lee et al). In fact, PDMS lens have been predicted to be created a sold for less than $.01 a piece (Lee et al).

The study will be conducted in order to not only make scientific tools more efficient, high-powered, with more portability and cheaper cost, but to advance scientific knowledge and interest in young students who otherwise may never be exposed to scientific information and equipment. Advancing scientific passion as well as knowledge is incredibly important to the future of the world, as scientific discoveries are made everyday.

Research Methodology:

<u>Research Question:</u>

Can cheap, simple, yet highly efficient microscopes be assembled from cured PDMS lens and other commonly-accessible materials in order to better advance scientific interest and knowledge?

<u>Research Hypothesis:</u>

Commonly used light-microscopes can be innovated by the addition of a simple, descriptive guide to curing PDMS lenses targeted for the general audience. Also, experimenting and identifying the optimal conditions and factors will create more efficient PDMS-based lenses with low cost, light weight, portability, assembly simplicity, and better optical focus and resolution.

Research Design Model:

The experimental research design is best suited for this conducted research because different factors which best affect optical performance of the microscope lens are found through experimentation. Quantitative research is to be conducted. There are several independent and dependent variables defined throughout the course of the research. For every experiment, one variable is manipulated so that by analyzing results, the most optimal experimental level for each variable is located. Ultimately, by combining the set of most efficient variables, a procedure to cure optimal lens can be created. Some independent variables include the temperature at which PDMS is cured, the curing agent to elastomer base ratio, and the surface on which PDMS is cured. As for the dependent variable, the optimal conditions created will be defined by a combination of various optical measurements which quantify the performance of a microscope, such as focal length and resolution.

Data Collection:

UMBC provides a lab notebook which is used to write lab objectives, procedures, materials, data, and ay observations. By dating and writing each experiment in the lab notebook, various experiments are organized and detailed, keeping data and observations recorded securely. Thus, all experiments and collected data are kept accounted for future references.

Product Objectives:

The final product resulting from this research will be a microscope-lens synthesis demo, including live-demonstration, guides, handouts, and/or time and resources for students to make their own microscopes. A demo will be given to an audience comprising of science students at a local elementary or middle school to inspire young students to discover their talent, aptitude, and enjoyment for science-related areas. The demo will consist of a presentation and procedure on how to cure PDMS safely and easily, as well as easy-to-understand, informational handouts kids can learn from regarding polymers, microscopy, optics, science, and research. If time and resources permit, the demo can be presented or guides circulated to other areas where students may not be as scientifically knowledgeable or financially fortunate, such as nearby poor urban areas, orphanages, homeless shelters, or regular science classes at a middle or high school.

From conducting this research and creating this final lab demonstration product, the kids or students themselves will benefit, perhaps even with a life-changing experience. Also, the communities and families of these students will also benefit, as the children are exposed to scientific knowledge as well as perhaps their passions. The US government, specifically within research, economy, technology, and education, will also indirectly benefit, as one of their main goals is to increase interest and education in STEM-related fields, especially for minority groups.

These outcomes will be communicated specifically via a live demonstration and/or distribution of informational handouts and guides on curing PDMS lens as well as creating the cheap, simple, do-it-yourself microscope.

Logistical Considerations:

For the conducted research and final product, print resources, media resources, human resources, and organizations will or may all be needed. Print resources include previous research papers, background information, including any equations or scientific jargon used in the research, as well as safety data sheets found on the website of the company which produces the chemicals used, which in this particular research, is Dow Corning. Media resources may be considered for use in the final product, as supplementary videos or photos on the step-by-step process to cure PDMS would deem useful. As for human resources, students from area that are poor, less educationally advanced, and/or less exposed to scientific information and research will be targeted as people to whom the demo can be presented.

UMBC Department of Chemistry and Biochemistry provides nearly all resources needed for this research, including monetary costs, chemicals and materials, as well as safety and laboratory equipment. The Kyoung Research laboratory provides the area from which all experiments are conducted. Permission to gather data and share the final product will be needed from UMBC Department of Chemistry and Biochemistry, and Dr. Minjoung Kyoung, the principal investigator of the lab. Permission will also be requested directly from the students to whom the final microscope-synthesis demo will be presented. Also, if presented to a school, permission will also be requested of the children's guardians, teachers, as well as the principal.

In third quarter, a timeline will be added that outlines the data collection, product development, and audience distribution.

Approval:

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Student Signature G/T Resource Teacher Signature Mentor Signature

References:

Lee, W. M., Upadhya, A., Reece, P. J., & Phan, T. G. (2014). Fabricating low cost and high performance elastomer lenses using hanging droplets [PDF]. *Biomedical Optics Express*, *5*(5), 1626-1635. http://dx.doi.org/10.1364/BOE.5.001626

Dow Corning. (n.d.). *Sylgard 184 elastomer kit* [Fact sheet]. Retrieved October 19, 2016, from Dow Corning website: http://www.dowcorning.com/applications/search/default.aspx?R=131EN

Vandervoort, K. (2014). Microscopy. In *The Gale encyclopedia of science* (5th ed.). Retrieved October 6, 2016, from http://ic.galegroup.com/ic/scic/ReferenceDetailsPage/