DESIGN AND PROTOTYPE LOW-COST EDUCATIONAL VERSION OF EXISTING LABORATORY INSTRUMENT

PROBLEMS WITH THE EDUCATIONAL TECHNOLOGY IMPLEMENTATION PROCESS

An Undergraduate Thesis Portfolio
Presented to the Faculty of the
School of Engineering and Applied Science
In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science in Biomedical Engineering

By

Peyton Billips

April 28, 2020

A SOCIOTECHNICAL SYNTHESIS

As technology becomes more integrated into the workforce and more jobs require digital knowledge, the need for properly educating students with technology will be critical for their success. Working with a Charlottesville based biotechnology company, the technical project aimed to adapt their multi well plate reader product for use in an educational setting. By addressing the specific needs of teachers, the design of the prototype and accompanying experimental procedure would provide a method for quantitative learning with a real-world laboratory instrument. While the technical project is focused on the creation of educational technology, the Science, Technology, and Society (STS) research was concerned with the process by which educational technology is implemented into the classroom. The research examines the implementation process, identifies the groups involved and the barriers that arise between the groups, and proposes a possible solution for overcoming those barriers. If the technical project were to be finished and eventually implemented into classrooms, the barriers identified through the STS research could affect the process and prevent it from being used by students. However, identifying the barriers is the first step to improving the process and the technical project provides an opportunity for testing the solutions proposed by the STS research.

The multi well plate reader is a scientific instrument that is used in most biology and chemical laboratories. It provides a method for collecting quantitative data, which is useful for understanding complex biological concepts. However, most plate readers are large and too expensive for a high school to afford. The Charlottesville based biotechnology company, Cerillo, has developed a miniaturized version of a multi well plate reader that has many of the same capabilities while providing a lower cost and smaller size. The technical project aimed to further

alter their product for educational use by interviewing teachers, and addressing the specific needs of their classrooms and curricula. By designing the modified plate reader around the feedback collected from the teachers, the device would be ideally suited to be easily integrated into the classroom and provide useful learning opportunities for students.

The technical project began by contacting biology and life sciences teachers from high schools in the Charlottesville area. Meetings were conducted with five teachers from four different schools and the most common feedback gathered was the difficulty that the teachers had with using quantitative data to convey topics that the students found hard to understand. With this knowledge in mind, the designs for the prototype looked to address those specific needs by reducing the size of the multi well plates from 96 wells to 24 wells, redesigning the plate reader casing to provide more durability, and using an older version of the electronic components to reduce the cost of the device. Unfortunately, the prototype was unable to be fully assembled and validation testing could not occur. The project shifted focus and instead developed an experimental module that could accompany any future finished versions of the device, and ease the integration process into the classroom. The module focused on the biological topics of bacterial growth and antibiotic resistance, and was still constructed with the needs of the teachers in mind while also highlighting the potential use of the device.

While the technical project aimed to develop a piece of educational technology, the STS research investigated the implementation process for that technology. By using the linear handoff model the research first examined the groups involved in the process, and then identified the social factors that affect each group and cause barriers to arise throughout the process. Primarily using studies that were conducted with the goal of examining the effects of educational technology, journal articles written around the topic of educational technology, and data that

reflected the social factors impacting the groups, the research was able to create a clear picture of how the implementation process can go wrong. After identifying those issues and studying successful implementations, a solution was proposed that aimed to provide guidance for how each of the groups could improve the overall educational experience.

The educational technology implementation process can be modeled using the linear handoff model, which shows how technology passes from one group to the next until it eventually reaches the intended end user. In the case of educational technology, the process begins with the engineers who pass it along to the administration and those who are in charge of making decisions for a school, then the teachers, before finally reaching the students. Throughout this process each group involved has the ability to impact the effectiveness of the technology before it reaches the end users. The social factors that affect each group will in turn affect the technology and cause barriers that prevent the technology from being used effectively in classrooms. However, a possible solution to overcome these barriers is to restructure the implementation process and instead of using a linear handoff model, the process should be designed after the social construction model which shows all of the groups having the shared goal of improving the educational experience. Active communication is a critical aspect of this solution, and without it the barriers discussed by the STS research will never be overcome.

TABLE OF CONTENTS