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Web-Based Inquiry: A Potential Solution For Resource-Poor High School Biology Classrooms?

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WEB-BASED INQUIRY: A POTENTIAL SOLUTION FOR RESOURCE-POOR HIGH SCHOOL BIOLOGY CLASSROOMS?

by

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CHAPTER ONE

Introduction

Opening

When reflecting on one's own experiences in a high school biology classroom, a number of memories may come to mind. My recollections range from frog dissections, to peering into microscopes, to copying complex definitions from a textbook. If asked to think about *biology lessons and engagement*, the thoughts of teachers lecturing and textbook reading will often fade away, leaving only thoughts of labs, group projects and hands on activities. However, for persons who attended a low-income school, memories of labs or activities can be scarce (Ossola, 2014; Caygill, Lang, & Coweles, 2010). According to the Bursar Office (2017) and Federal Student Aid (n. d.), low-income schools are designated by the Department of Education as schools that serve predominantly low-income families, with typically at least 30% of the students on free and reduced lunch. Despite attempts to provide supplemental funding to these schools, the current policies for assigning personnel and distributing resources leave low income students shortchanged (U.S. Department of Education, 2011).

With science classrooms often requiring some of the most expensive and specialized academic equipment, institutions with tight budgets can be forced to cut or limit these more expensive parts of biology classrooms. With these limitations, learning can be stunted and the problematic achievement gap can further be exacerbated, with resource poor schools often serving some of the most at need students (U.S. Department of Education, 2011). This illustrates the problem of instructors wanting to create the type of engagement seen in labs and with hands-on learning, yet having limited resources and budgets to do so. How do teachers in resource poor schools work to close the achievement gap with what limited means they have available without breaking their own banks?

This problem ultimately leads to my research question: What are design principles that support the development of web-based guided inquiry lessons for resource poor secondary biology classrooms? Throughout the rest of Chapter One, the personal journey to this research question will further be described. This chapter will also highlight the broader context of what population this project will be designed for, how it will be organized, and explain the impact it is designed to have.

Journey to the Question

I entered the high school classroom in 2013 through a non-traditional approach, Teach for America (TFA) (n. d.), a program known for placing recently graduated college students into low-income schools. Their training program highly emphasizes the importance of an excellent and equitable education for all students. Both in the summer training institute before entering the classroom and throughout the academic year during professional development Saturdays, the program uses these opportunities to stress the importance of finding innovative and effective teaching strategies to bridge the achievement gap. In conjunction with its own organized professional development, the state where I worked as a teacher requires that TFA teachers be placed in a licensing program. TFA partnered with a university teacher preparation program, which enrolled corps members in the licensing and if desired, Masters program.

I was placed at a charter high school, serving a predominantly East African population, with 99% of its students on free and reduced lunch. Upon entering the classroom, my students were eager to learn and were most engaged when participating in group activities or hands-on lessons. They also looked forward to days where I requested laptops. During classes when students were able to use technology, I saw increased engagement and little distraction despite my initial concern about off-task behavior. While computer literacy is not the focus of my Capstone, it is important to acknowledge the additional benefit of implementing lessons that use technology. Grundmeyer and Peters (2016) note how this skill is a critical component of college readiness and an important to generate in high school classrooms.

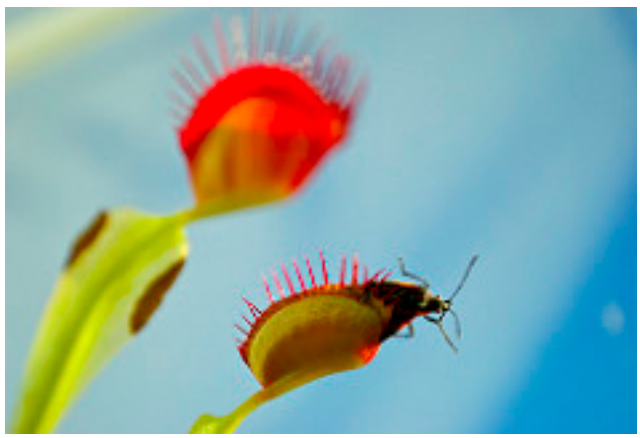
Not only was I trying to incorporate more technology into my lessons, I also found myself trying to be as innovative as possible in lesson design, as the resources at the school were limited and funding science laboratories was not a priority. I submitted requests for materials, but was often turned down or was only allowed the amount of supplies that would be useful for a demonstration. I knew demonstrations were better than nothing, but I still felt that this kept the learning centered around me. In order to remove me from the center of the classroom, I decided to use student volunteers whenever possible to complete the demonstrations in front of the classroom rather than having me lead. However, when I was able to have a student volunteer, I felt disappointment from the other scholars in the classroom, as this only allowed one or two students to complete the demo while everyone else was only able to watch. I struggled a lot with this, but continuously used the internet to find different resources and ideas to make my classroom environment one of active learning.

Active learning is defined by Elliott, Combs, Huelskamp, and Hritz, (2017) as learning that engages students "in higher-order tasks, such as analysis and synthesis, which is a crucial element of the movement toward what is commonly called "learner-centered" teaching" (p. 38). Eventually I had the opportunity to learn more formally about this type of learning, taking a methodology course that introduced teaching styles specifically for secondary science classrooms. This course provided guidance on how to design science lessons specifically focusing on the importance of guided inquiry and its structure. Guided inquiry is defined by Lee (2012) as a type of active learning that is geared toward "promoting the acquisition of new knowledge, abilities, and attitudes through students' increasingly independent investigation of questions, problems, and issues, for which there often is no single answer" (p. 6).

This class was extremely formative for me as an educator. I knew the inquiry-teaching style was not only the way I should be teaching but *needed* to be teaching. My goals were not only to attain educational excellence, but to get my students invested in science. I wanted to steer away from a teacher-centered classroom to one where my students took a more active role in their learning. In a study done by Henry (2017), active learning was seen to be correlated with higher grades and increased content understanding. Furthermore, Freeman et al. (2014) found that when science, math, and engineering classrooms become dependent on lecture-based teaching, failure rates in these courses increase by as much as 55%. Inquiry was a clear path to ensuring active learning and staying away from lecture-based lessons. It allowed my students to be true scientists in a science classroom with questions driving their learning.

Taking these pieces, guided inquiry, technological literacy, and limited resources, I decided to attempt to design a web-based inquiry lesson. This would allow for the student centered learning I wanted, without the resources that I so often lacked. As a

Science Technology Engineering and Math school, laptops were available most days. Centered around the daily objective, I found websites, labs, pictures, and videos online that I could use to teach the lesson. In selecting these resources, I only used ones that were free for the public. I did not only look up the lesson of the day and click on the most popular resources, but I dug through the many sites that came up when I plugged in my search terms. I also tried to be creative and look up concepts that were outside of the box. For instance, a picture of a Venus fly trap (Figure 1) was used during a lesson on photosynthesis.



Gavey, D. (2010, October 9). *The Struggle* [Photograph]. Licensed under Creative Commons on flicker.com

Students were asked to explain based on their knowledge of what they had learned about cellular respiration and photosynthesis, which did they think was completed by a Venus flytrap and why? This idea didn't come from searches of photosynthesis or cellular respiration, but by thought and consideration of the class objective.

My school had Blackboard, an online digital learning environment, which allowed me to create modules ("Blackboard Classroom," 2018). This allowed for a structure in which students went step by step through the tutorial until completing the lesson. They were given a packet to complete as they went through the module. These packets were designed not only to have them answering multiple choice questions but had them engaging with the material on a deeper level. I had them completing graphic organizers, drawing pictures, and asking questions for me to consider.

The packet was designed intentionally to use an inquiry style approach, with each module building on the last, until students were finally required at the end to synthesize and analyze what they had learned. At times I had students partner to work through the assignment and at other times I had them do the assignment individually. Each time I used this strategy I found my scholars were very engaged, loved the lessons, and mastered the content. Exit tickets were evidence to show that utilizing the web-based inquiry learning with my students consistently allowed them to achieve mastery. My students attained as high or higher levels of mastery on the content presented using the web-based inquiry approach as compared to other teaching strategies. My students' mastery of the material, along with the resource deficits I experienced in the classroom, have both highlighted the importance and demonstrated the necessity of web-based inquiry lessons for teachers in resource poor environments.

Project Introduction

Moving forward with this project, I envision a website, where these lessons will be available for free to high school biology instructors. The modules will be built and structured for easy navigation for students. I will also post packets for printing to go with the online lesson. This project is designed for teachers and students at schools where computers and headphones are available, but other resources are limited. This is not an uncommon situation as computers are present in most schools, but other supplies can be harder to come by (U.S. Energy and Information Administration, 2016; Caygill, Lang & Coweles, 2010). This project is important as it is a tool to increase inquiry-based learning in schools with limited means, without increasing teacher stress. Rather than teachers being focused on scrambling for unattainable materials, pulling money from their own pockets, creating lessons from scratch or spending hours investigating what websites and online activities are worthwhile, they can focus on lesson delivery and supporting their scholars. While this project comes from the desire to help resource deficit schools, I could see this also being used in several other capacities. Teachers could use it for additional learning for students who may struggle with a certain topic, for days when substitutes are in the classroom, or for a review session on a topic that the whole classroom need reinforcement in. I do not see this curriculum as a replacement of what teachers are already doing in their classrooms, but a means to teach a topic that they may struggle to do without falling back on a lecture style, teacher-centered environment.

Summary

Inquiry and active learning are important for student engagement and achievement (Freeman et al., 2014). While most educators want to be teaching these ways, they may have limitations in supplies to be able to do so. Inquiry lessons, especially in the sciences, can turn out to be some of the most expensive as they are often centered around labs. Labs can call for numerous and specific supplies. Ensuring all teachers have meaningful ways to educate and invest their scholars in science, is something that I am passionate about. Creating a web-based inquiry program could serve to allow similar levels of student engagement and achievement without relying on expensive labs and activities to teach the lessons. My trainings with TFA, the environment I originally taught in and the struggles I experienced as an educator all shape my desire to create a free, online, inquiry-based curriculum for teachers to use. While not a perfect replacement for hands on lessons, this resource could be used to supplement science classrooms without sacrificing active learning.

Continuing Forward

Moving forward, the evidence, design and description of this web-based inquiry project will be described. Chapter Two will focus on the rationale for the project. It will outline the background and justification for the proposed research question, utilizing previous findings and evidence to support this project's creation. Additionally, it will clearly define key terms identified in the research question and important vocabulary associated with the topic of interest. Chapter Three will discuss the project description in detail. Finally, Chapter Four will provide a reflection of the Capstone project, including limitations and critique on its design.

CHAPTER TWO

Literature Review

Overview of Chapter One

A school receives a low-income designation by The Department of Education if the school serves predominantly low-income families, with typically at least 30% of the students on free and reduced lunch (Bursar Office, 2017; Federal Student Aid, n.d.). These schools, due to inequity of funding, can often be some of the most poorly resourced, lacking supplies and putting additional pressure on teachers. Looking to the issue of resource deficit classrooms in low-income schools, this project's research question is: What are design principles that support the development of web-based guided inquiry lessons for resource poor secondary biology classrooms? This chapter will review the literature relevant to the research question, focusing on assessing the need for innovative learning styles in resource-poor environments, the incorporation of technology into the classroom, and the space for inquiry in that integration.

The review begins by first examining the disparities seen in low-income schools compared to higher-income schools. Furthermore, it will focus on how these disparities affect the learning environment, instructors, and outcomes of students. In assessing the gaps and obstacles to providing students effective learning environments, the importance and need for the capstone project will be identified. Then the review delves into the emergence of inquiry into the classroom, starting at its roots and then diving deeper. It describes the different interpretations and types of inquiry-based learning that exist and the reason why it has become so highly adopted and promoted in the education sphere, especially the sciences. This section also looks at critiques of the inquiry- based learning approach and how this project is outside the scope of many of those criticisms.

Finally, it looks at the role of technology, specifically the internet on education. Not only does it touch on its evolution, but delves further into the development of inquiry-based online activities and lessons. This section also looks at the issues raised regarding technology in the classroom, most specifically the digital divide. In answering this concerns, the literature review finishes up by looking at the gap that still exists in this part of the education field. In this gap, is where the importance and justification for this project lies.

Low-Income Schools and Resources

Low-income schools are defined by the U.S. Department of Education as schools that serve a high concentration of low-income families, with typically over 40% of students receiving free and reduced lunch services (Bursar's Office, 2017; Financial Aid Office, n. d.). The U.S. Department of Education (2015) also notes how schools in high poverty districts devote 15.6% less funding per student compared to low-poverty districts. Schools that are low-income can often be deficient in resources due to this lack of funding. Due to the strong connection between lack of funding and availability of resources, this paper will focus on addressing the resource inequity, and refer to schools as "resource-poor." The educational outcomes of low-income schools can also be poor. For example, according to Tinto (2012) approximately 19% of students who are considered low-income have six-year graduation rates as opposed to 49% of higher income students.

These problems described by the Department of Education (2015) and Tinto (2012) are vast, persistent, and are only continuing to get worse. From 2002 to 2014, Barshay (2015) found that the gap between funding of students in the richest districts versus the poorest grew 44%. This inequality manifests in numerous ways. In a study conducted by Obidah and Howard (2005), the researchers found that many urban, low-income schools have higher rates of absenteeism and lower test scores. Another way inequity exists in low-income environments is in limited access to advanced placement classes. Deruy (2016) cites that students of color, who make up a majority of the population of low-income schools in urban areas, are less likely to be enrolled in advanced coursework. While black and Latino students make up 31% of students, they only fill 21% of the advanced placement seats in calculus courses.

Doerschuk et al. (2016) describes another way the disparity in educational funding manifests itself, as the significant negative impact it has when students leave the high school classroom. This is particularly true in science, technology, engineering and mathematics (STEM) where students from low-income backgrounds suffer the most. A report from The National Student Clearinghouse (2015) reported that only 6% of students from the class of 2008 who came from high-minority, low-income high schools received a degree in STEM as opposed to 17% of students from wealthier districts.

Given the poor outcomes in STEM for students from low-income schools Lee (2016) describes how the INCLUDES program has designed initiatives to facilitate entrance of students from these diverse backgrounds into the sciences. The INCLUDES program, established by the US National Science Foundation, channeled $14 million focusing on getting students who are disadvantaged into the sciences. Despite groundbreaking initiatives like this, students with some of the highest needs are still getting the least amount of resources (Strauss, 2012; Obidah & Howard, 2005). For example, Semuels (2016) points out that in Connecticut, richer districts spend on average $6000 dollars more per student than poorer districts. Due also partially to the inequity of funding, the teachers in low-income schools also face their own set of obstacles.

Studies conducted by Lankford, Loeb, and Wyckoff (2002) and Hanushek, Kain, and Rivkin, (2001) have shown that teachers, over time, will leave jobs where there is a high proportion of students with a low socioeconomic background, low levels of achievement and a high proportion of students of color. This departure is due to a multitude of compounding factors such as those described by Johnson, Kardos, Kauffman, Liu, and Donaldson, (2004), who state that educators in low-income schools do not receive the same amount of support in the areas of "hiring, mentoring, and curriculum than their counterparts working in schools with high- income students" (p. 5). Skaalvik and Skaalvik (2007) describe another reason teachers depart from low resource schools. According to these authors teacher burnout is common with job-related stressors leading to instructors feeling overburdened and overwhelmed. These feelings of burnout are especially important to moderate, as teacher stress is linked both to student outcomes and teaching effectiveness.

When working to combat burnout, another consideration for science teachers is the search for supplies. This can be one of most burdensome tasks for teachers and school staff. The Trends in International Mathematics and Science Study (2010) conducted by New Zealand government, found that principals felt that a lack of science resources had the most deleterious impact on instructional quality. Caygill, Lang and Coweles (2010) found that over 80% of the principals saw the lack of science resources as negatively affecting the classroom environment. Rural low-income schools in the US also feel the effects of lack of resources. Ossola (2014) found that rural low-income schools often cite not only not having laboratory supplies, but not having the science laboratories at all to conduct the experiments detailed in the curriculum.

On the other hand, some researchers, like Hanushek (1997), have found that resource deficiency is not the cause of the inequality seen between schools. He cites that while student funding has increased, there has been limited changes in student achievement. This researcher brings up potential for family input and class size as being more important influencers in student success. Taking these critiques into consideration is important as there are a multitude of factors, not only a lack of resources, that contribute to the achievement gap.

With a multitude of perspectives on the issue, several different strategies have been proposed to bridge the achievement gap seen in low-income environments. Funding restructuring to ensure low income schools get their fair share, specialized initiatives and programs directed at getting low-income students into STEM programs, and reforming teacher training programs have all been cited as potential pathways to mitigate the disparity seen between low-income schools and less impoverished institutions. While these larger concepts are important to evaluate and to continue progress on, for teachers in the classroom now, more immediate action is crucial. In alleviating both burnout and financial strain, it is imperative to provide educators with useful resources that do not add any additional stress, time, or supplementary funding to use. This Capstone project will serve as one tool for science educators to utilize until these larger systemic issues are addressed. Despite the limitations that educators in low-income environments face, innovative and effective teaching strategies can still be implemented. Inquiry-based education has been one means by which teachers in resource-poor environments have begun to bridge the achievement gap.

Inquiry-Based Learning

Inquiry is defined as "seeking for truth, information or knowledge or understanding and is used in all facets and phases of life" (*Approaches to Inquiry Based Learning*, n. d., p. 1). This style of thinking, has increasingly been incorporated into classrooms, especially science lessons, guiding teaching practices and curriculum structure. Inquiry-based learning is not a new idea, despite becoming more common. Looking back as far as Socrates, one can see the existence and emphasis of questioning and curiosity in the learning process (Intel Corporation, 2017). While not a new concept, according to the National Research Council (2000), inquiry was really first introduced into mainstream practice during the educational reform of the 20th century. John Dewey, a philosopher of education, valued the process of learning and ability to think scientifically. This was revolutionary for the time, as most working in education during this period focused on the amount of knowledge gained, rather than the process of learning and the curiosity that drives it.

From the time of John Dewey and moving forward, the terminology "inquiry" and "inquiry-based learning" have become increasingly integrated into conventional educational practice. Marshall and Alston (2005) noted that in the education sphere, especially in the sciences, there has been a transition from focusing on lower-order thinking skills, like recall and defining, towards higher order thinking, like evaluating and creating. Lee (2012) defined inquiry-guided learning as a type of active learning that is geared toward “promoting the acquisition of new knowledge, abilities, and attitudes through students’ increasingly independent investigation of questions, problems, and issues, for which there often is no single answer” (p. 6). Provenzo and Provenzo (2009) describe active learning, the umbrella which inquiry falls under, as calling for students to operate at higher cognitive levels. They define it as an educational approach that asks students to apply and reflect on classroom content. It requires students to work to “solve problems, work as part of a team, provide feedback to classmates, or peer-teach as ways to put new content to work” (p. 12).

The adoption of inquiry and its tie to higher order thinking is further highlighted in the changes made to the Next Generation Science Standards (NGSS). The NGSS (2012) recently adopted inquiry in their standards, citing and emphasizing the importance of higher-order critical thinking skills as the justification. According to the National Teachers Science Association (n. d), since December 2016, over 35% of US students are being affected by these changes. Eighteen states have adopted NGSS, highlighting the increased acceptance and emphasis placed on inquiry in the classroom.

There have been numerous interpretations and adaptations of inquiry into the learning environment. While commonly called inquiry-based learning, Kirshner, Sweller and Clark (2010) point out that it can also can be referred to as experiential learning, problem-based learning, discovery learning, and constructivist learning. While understandings of inquiry-based education can be slightly different, Jennings (2010) points out they are all focused on the learner gaining knowledge through active investigation. For this project, the curriculum will be developed based on a guided-inquiry approach for practicality. As an online, pre-made resource, the curriculum designed is focused on ease for the teacher, requiring little background knowledge, preparation and introductory materials necessary for students.

Guided-inquiry, unlike discovery and more open-ended forms of inquiry-based learning, has targeted instructional interventions at each stage of the learning process throughout a lesson (Kuhlthau, Maniotes, & Caspari, 2015). Rather than students forming their own questions and driving the lesson, the teacher has a more involved role. According to Sadeh and Zion (2009) in guided-inquiry, the instructor will often draft a question, that students will then investigate in a manner guided by the teacher to come to a predetermined answer. Saden and Zion (2009) further point out that open inquiry is much more flexible. This process allows for students to not only draft their own questions but also develop their own means to answer them.

Overall, the reception of inquiry into the classroom as a teaching style has been mostly positive. Lambert (2007) found that inquiry promoted a range of skill sets including "knowing, inferring analyzing, judging, hypothesizing, generalizing, predicting and decision making" (p. 389). Alongside being tied to higher order thinking, it also allows students to connect their current learning environment with prior knowledge (Nico Rutten, van der Veen & van Joolingen, 2015). In a meta-analysis of 72 studies, Lazonder and Harmsen (2016) found inquiry to have a positive effect on performance and learning outcomes. The study also found that the amount of guidance given to the students affected performance success, with strong guidance, but not strict to be important factor. Several studies including one conducted by Schroeder, Scott, Tolson, Huang, and

Lee (2007) and another by Vlassi and Karaliota (2013) found that inquiry projects also had a strong positive effect on student achievement.

Along with student achievement, inquiry has also been heralded for its ability to increase student interest in science and potentially decrease the achievement gaps seen in low-income environments. Specifically, in urban environments, several studies have shown inquiry to be successful in mitigating that difference (Seiler, 2001; Marx, et al. 2004). In a study done in over 7,000 students enrolled in Detroit public school by Marx et al. (2004), an increase in curriculum-based test scores was associated with implementation of inquiry-based technology infused curriculum. Furthermore, in a study done by Arepattamannil (2012) in students of Qatar, when inquiry-based teaching was implemented there was increase seen in not only student achievement but also interest in science. Teaching strategies that decrease the disparity seen in student achievement is crucial. This problem is clear as The National Assessment of Educational Progress (NAEP) (2012) found that students from minority backgrounds score significantly lower on science assessments in comparison to their white peers. Below 50% of eighth grade African American students and Hispanic students scored at or above proficient on the NAEP science test compared to 80% of white students.

Despite the widespread integration of inquiry into the classroom, it has not come without resistance. There have been numerous trepidations and critiques raised over its implementation. Kirshner et al. (2010) cite that minimally guided instruction to be less effective and efficient than those that have strong guidance. These researchers believe the due to the limitations to human cognitive architecture, a student's working memory is limited and the inquiry process doesn't allow for enough space for long term memories to be made.

These critics have advocated for traditional direct instruction. Citing that inquiry does not provide sufficient structure for student learning, allowing for students to waste time on disorganized activities. Mayer (2004) questions inquiry's effectiveness, when applied with a lack of guidance. He also takes issue over the lack of organization associated with this teaching strategy. Concerns also have arisen in terms of inquiry and the amount of time it requires. Markham (2013) mentions the resistance to this approach with schools often on tight timelines. The practicality of inquiry-based learning, while also having sufficient time to prepare for significant standardized tests has been raised as a cause of concern.

There is less critique towards more structured, guided inquiry which allows less freedom and more structure to guide students. In a response to Kirshner et al. (2010), Hmelo-Silver, Duncan and Chinn (2007) note the authors conflation of the terms inquiry learning and discovery learning as synonymous terms, when inquiry learning will often call for scaffolding. Despite its critiques, overall, inquiry has been found to generate higher-order thinking skills and allow for deeper engagement with their learning. This project, which will take a guided inquiry approach for curriculum development to ensure usefulness for teachers, will provide the scaffolding that many who oppose inquiry point to as the culprit for its ineffectiveness in the classroom.

Integration of Technology and Inquiry

Utilizing technology in the classroom has become increasingly popular. Whether it be smartphones, tablets or computers, teachers are rapidly incorporating these devices into daily educational life. Looking back in time, computers were first introduced in the 80s and it did not take long for them to enter the classroom. According to Purdue University (2017), by 2009, 97% of classrooms had at least one computer, 93% of these computer had internet access, and educators reported that 40% of their students used this technology often in their educational methods.

From here schools have only becoming increasingly more technologically connected. Dobo (2016) reported that the number of schools with devices increased 71% from 1999 to 2012. This is two times the increase that was seen in other non-residential buildings. Furthermore, in a report by the U.S. Energy and Information Administration (2016), found that nine out of ten schools have computers for their students. It has not stopped at computers, but also can be seen through the establishment of hotspots, the commonality of smartphones and the increasing number of online academic classes. It is evident that technology has infiltrated the education sphere and it is here to stay.

Technological integration is defined by Edutopia (2007) as “the use of technology resources -- computers, mobile devices like smartphones and tablets, digital cameras, social media platforms and networks, software applications, the Internet, etc. -- in daily classroom practices, and in the management of a school” (What is successful technology integration?, para 1). With the vastness of the internet, over five hundred billion deep web-documents estimated by Bergman (2001), the options for educators are endless. However, concerns have arisen over how effective online, virtual options are compared to the standard hands on alternatives. According to Dillon (2006) during the 2005 A.P. biology exam administration, 61% of students passed with a three or above nationwide. Students who took the class virtually via the Florida Virtual School and the Virtual High

School had passing rates of 71% percent and 80% respectively. This could suggest the use of virtual labs as a supplement to the current practice. While these have not become standardized, one of the ways educators have begun using the internet, has been the creation of several inquiry-science based online resources and simulations.

These online curriculums have included WebQuest in 1995, ScienceWare in 1997, followed shortly behind by Biology Guided Inquiry Learning Environment (BGuiILE) created by Northwestern (Pryor & Soloway, 2000; Northwestern, 2009; Molebash & Dodge, 2003). BGuILE focused mainly on natural selection and ecosystems, while both WebQuest and ScienceWare were more broad in their content coverage. WebQuest was created by Bernie Dodge and Tom March with the intention of creating a resource that would have students focused on using the information for lesson and not looking for it (Molebash & Dodge, 2003). Molebash and Dodge (2003) describe the WebQuest website (Dodge, 2017) as having thousands of lessons available that have been created by teachers. These lessons focus on various school subject and topic areas. They differ in quality, but all share a similar structure with an introduction, task, process, evaluation and conclusion.

A number of these online inquiry- based lessons and software have proven to be effective and helpful within the classroom. Limson, Witzlib, and Desharnais (2007) describe utilizing another inquiry-based lesson website, Virtual Coursework to teach a lesson on genetic inheritance utilizing drosophila. Virtual Coursework offers free, online, experimental simulations that students can complete virtually. The activities being offered by Virtual Coursework are novel, experimental, and stress inquiry throughout the process. In the researchers' observations of the lesson provided by Virtual Coursework, they saw high levels of engagement among all students, application of higher-level thinking skills, and understanding of the content. Another benefit pointed out by Pryor and Soloway (2000) in their introduction of inquiry-based web activities to the classroom, is that it increases student readiness for entrance into the workplace.

Not only have web-based inquiry lessons been shown to be effective at increasing student engagement, a study conducted by Raes, Schellens, and De Wever (2013) in 19 secondary schools demonstrated that this teaching strategy has potential as a resource to engage students who are not typically successful in science or who are not enrolled in a science track. Findings from a study by the Alliance for Excellent Education and the Stanford Center for Opportunity in Education (2004) showed similar findings. The report, based on the review of over 70 recent research studies found that when used properly, technology can lead to high gains in student achievement and boost engagement. This was found to be especially prominent among students who were considered at highest risk of dropping out.

Despite studies showing the potential benefit for technology in the classroom for all students, as it becomes increasingly present, concerns have also arisen over its integration. The biggest concern has been dubbed “the digital divide.” The digital divide, has numerous definitions but the concerns it brings about lie in the difference of access and utilization of technology of low- income students vs. students from higher-income backgrounds. It is outlined by Pacheco (2012) as the difference in access to the internet and Wi-Fi at home. While Pacheco believes this difference in accessibility to internet at home is creating the digital divide, other research has shown that it is not necessarily access but content and utilization that is influencing this disparity. Hutt (2016) reports that students from low-income backgrounds are more likely to use their time online to play video games or chat. Students from richer backgrounds are more likely to spend time searching for information.

Both of these concerns are important to consider when examining the digital divide and use of technology in creating assignments for work students complete at home. As this project focuses on curriculum created for use in the classroom, the differential access to Wi-Fi at home will not be an issue for its implementation. Also as it driven by free, informational, and online sources, it could increase abilities for students search abilities for content and information, as it utilized websites that offer information on science topics they may be struggling with.

Another barrier more specific to not only web-based resources, but web-based inquiry lessons was pointed out by Chang, Sung and Lee (2003). These researchers note the vast nature of the internet with its infinite number of resources for science teachers to utilize in their lessons. While comprehensive, the sheer number and amount of resources available along with lack of structure and organization to these assets, leaves them lacking usability in the classroom. This project focuses on adding the structure to these resources, creating meaningful inquiry lessons for teachers, so they do not have to use time to search and organize these resources on their own. While some software focused on inquiry-based strategies have come out since Chang et al.'s (2003) assessment, including WISE and CIL, no software has focused on the utilization of the already existing and valuable materials on the web. By putting these resources into an "easy arrangement of various activities for classroom practice, this could "empower teachers' instruction a lot" (p. 57). In Shive, Bodzin and Cates' (2004) study, they assessed the availability and number of web-based inquiries available for chemistry. The investigators found that any pre-structured web-based inquiries were highly limited. However, they also found that there were plenty of websites that had the source material necessary for web-based inquiry lessons, they just were not pre-made, highlighting the potential for a project like the one proposed.

The potential for web-based inquiry programs based upon the amount of material already out there on the internet and the benefit they can provide both the student and teachers, suggests the need for creation of more pre-made inquiry based activities.

Summary

This chapter provided a review of the previous research and background knowledge for the research question focused on investigation into the design principles that support the development of web-based guided inquiry lessons for resource-poor secondary biology classrooms. From the review, it is evident that there is a need to still work towards equitable educational experiences in low-income schools compared to higher -income environments.

One approach to this challenge has been seen through the use of inquiry-based learning in the classroom, which has shown to provide higher levels of engagement and student achievement. In schools where resources are limited, but computers and internet access are still widespread, one means of doing this could be through the utilization of web-based inquiry lessons. These have shown to be especially effective in mitigating the achievement gap. While there are several types of activities and virtual labs that exist, they often lack structure and organization to make their use easy for time-crunched teachers. Moving forward into Chapter Three, the design of the curriculum will be described, highlighting the use of the abundant and free resources to establish a free inquiry-based learning curriculum website. This will be created incorporating a backwards-design approach.

CHAPTER THREE

Project Description

Introduction

Teaching high school biology in a low-income school, I struggled to find the necessary lab supplies to implement the hands-on learning activities commonly found in inquiry-based lessons. This deficit in materials and limited financial support led me to identify the importance and need for the creation of virtual inquiry lessons. While some classrooms lack lab supplies, most classrooms still have access to computers and the internet. The review of the research literature supports the need for low-income schools to have equitable access to inquiry-based materials and from there my research question is, "What are design principles that support the development of web-based guided inquiry lessons for resource poor secondary biology classrooms?"

Chapter Three will provide an overview of the project, highlighting the methodology behind the development of this online, inquiry-based resource. It will also provide information on the setting and target audience. A brief rationale will be provided for the decision in methodology for curriculum design, emphasizing some of the literature that supports this framework.

Project Overview

The main purpose of this project was to design a curriculum to supplement high-school biology classrooms that are limited in their resources. Rather than teachers be those that are expected to find the funds and means to teach hands on laboratories and activities, educators instead will be able to freely access curriculum compiled of inquiry-based lesson plans that can be completed by students using only a laptop, headphones, and printed materials. All supplies and directions are organized and available on a website, created using Weebly (Weebly, n.d.). While teachers should circulate during the lesson and provide assistance where necessary, the assignments were created with the intention of being completed primarily independently. This was done through creating student packets, teachers can chose to print prior to class. The packets are designed to guide students through the lesson explaining how to find each link. The links and resources the students are using are compiled on the website I created, organized to ensure their accessibility and use.

These lessons were created using a guided inquiry-style. In a study conducted by Lambert (2007), inquiry was found to promote processes such as hypothesizing, inferring, predicting and analyzing. Specifically, it has been seen to be especially beneficial in resource-poor schools (Seiler, 2001; Marx, et al., 2004) in increasingly student achievement. The main resources that was used when creating the curriculum was the Understanding by Design Framework, outlined by Wiggins and McTighe (2005) and a modified version of this framework from Vanderbilt (Bowen, 2017). Objectives were taken from the National Research Council (2012) and from the frameworks defined by the Minnesota Department of Education (Frameworks, 2018). The objectives from the National Research Council were used as these science objectives are becoming increasingly incorporated into science classrooms across the United States. These objectives were also selected as they integrate the core tenets of inquiry and crosscutting concepts for life sciences. I also incorporated the State of Minnesota's science standards as I am both familiar with them and they overlap with the standards outlined by the National Research Council. Due to the nature of the project, being standalone lessons, the main form of assessment will be a summative assessment for each specific lesson. It will be in the style of an exit ticket, allowing for teachers to track the student's understanding of the lesson objective.

Rationale for Curriculum Design

The Understanding by Design framework (Wiggins & McTighe, 2005) has been increasingly utilized to plan curriculums across grade levels and content areas. With its focus on student outcomes, easy to follow template and logical flow, it is easy to see why this design style has risen in popularity. Rogers-Estable (2015) points out the strength in teachers defining student outcomes in order for educators to plan lessons, they need to know where they want their students to end up. Furthermore, according to McTighe and Seif (2003) backwards design is especially effective as it "helps to avoid the twin problems of 'textbook coverage' and 'activity-oriented' teaching in which no clear priorities and purposes are apparent" (p. 1). This curriculum design avoids these problems, by focusing on student results.

This principle and focus is especially important in inquiry-based lesson design, where critiques have been raised based on concerns on if lessons designed with an inquiry focus lack of organization and direction. Backwards planning of lessons allows for a clear pathway to be designed from student activity to student outcomes. Not only does backwards design allow for a clear direction for the lesson, but also has been shown to increase learning. In a study done by Almasaeid (2017) in 8^{th} grade science classrooms, the implementation of Understanding by Design (Wiggins & McTighe, 2005) and backwards design approach resulted in an increase in Academic Achievement Science Test scores. As this curriculum design allows for a clear, directed approach to lesson design and is suggested to have a positive impact on student learning, it was used in the creation of this capstone project.

Summary of Understanding by Design Framework

The Understanding by Design Framework (Wiggins & McTighe, 2005), is composed of three main components; identifying desired results, determining acceptable evidence, and planning learning experiences and instruction. I used a modified version of this framework developed by Vanderbilt (Bowen, 2017). While using the same design principles in creation as the UbD, this framework has a template that provides the simplicity and directness that I think is most conducive to an online lesson plan delivery. In developing this curriculum, I first started by pulling the objectives I wanted to create lessons around. After gathering the objectives I was interested in including, I started brainstorming and searching for what content online was available, looking for virtual labs, media, pictures, and readings to build my lessons. From here, I developed exit tickets that measured the students' mastery of the content, based on my selected objectives. After developing these, I was ready to start putting together my lessons. I ended up creating four standalone lessons focused on: invasive species, the relationship between DNA, genes, and chromosomes, homeostasis, and how ecosystems are affected by competition and finite resources.

The lesson packets for students were developed alongside developing the lesson plan for the instructor. I focused on creating lessons where students began with making observations, brainstorming, and developing hypotheses. As inquiry-based lessons, when creating this curriculum, I ensured they were online investigations for students. Towards the end of each lesson, I added a piece of literature or video for clarification to ensure students were not walking away with misconceptions. Finally, I included in each student packet a piece for the scholars to engage further with the material, providing higher-level and critical thinking questions. This part of the lesson, asks students to apply what they learned throughout the lesson to more complex situations and topics.

Setting

This resource is presented in an online website template. It is free and easily accessible. For promotion of the resource, I will post information on teacher centered websites like Teachers Pay Teachers (n. d.) and utilize social media, specifically Twitter to disseminate information about my resource. In order to ensure teachers can find my website when using search engines like Google, Yahoo and Bing, I will add search functionality to my website. Furthermore, I will rely on word of mouth and reach out to teacher colleagues to increase the the visibility and use of this curriculum. The webpage includes a brief summary of the resource, including a description of how the project came to fruition and a short statement on how to use the curriculum. It also has a contact forum, where teachers who find the resource can both email me as well as submit questions into a contact forum. I encourage both feedback and questions and sending me any ideas for lesson development. This webpage highlights the use of this curriculum as a supplement to classroom units, where teachers may struggle to find supplies or if a teacher knows they are going to have an absence, but don't want to miss the opportunity for learning time.

Audience

The curriculum developed is targeted at high-school biology students (9^{th}-12^{th} grade). While not intended for AP and honors level courses, it could also be used in these environments for review or objectives that overlap in content. Also, middle school life science teachers, who often teach similar content to high school biology teachers, may find the lessons useful. While it has broad use in life science classrooms, it was mainly created for use in at low-income schools where students may lack access to lab equipment.

Summary

This chapter provided a description of and rationale for utilizing the modified Understanding by Design (Wiggins & McTighe, 2005) framework for curriculum design produced by Vanderbilt (Bowen, 2017). It also elaborated on the incorporation of guided inquiry into this curriculum design template, focusing on enduring understandings with a clear goal and outcomes for the lesson designed. Additionally, it highlighted the source of the objectives for the lessons being taught, using the National Science Standards (2012), which are becoming increasingly incorporated throughout the United States and the Minnesota State Standards (Frameworks, 2018), which overlap in content. Finally, this chapter discussed the target audience for the project, as well as plans for its dissemination.

This Capstone project assesses the research question “what are the design principles that support the development of web-based guided inquiry lessons for resource poor secondary biology classrooms?” The curriculum created will be a resource for teachers who are in resource poor environments, who often do not have access to enough supplies to complete expensive activities and labs. Chapter Four will include the results of the curriculum design, looking at lessons learned during the Capstone process and reflect more on the implications and limitations of the created resource.

CHAPTER FOUR

Conclusions

Introduction

When I entered the high school biology classroom as an instructor, I knew it would come with challenges. I expected for my abilities with behavior management to grow with experience, struggle at times to communicate complex topics with my students, and have moments where defeat would sink in after a lesson I delivered went awry. However, what I didn't expect was the dearth of supplies that would be available to me as an instructor. I was aware that school budgets were limited, but I didn't know how much it could impact my lessons. Often supplies were out of reach and activities were impossible without breaking my own bank. This Capstone project has allowed me to create a resource for teachers in situations similar to my own, delving into the research question: What are design principles that support the development of web-based guided inquiry lessons for resource poor secondary biology classrooms?

Through this project, I was able to create a free, web-based, online inquiry resource for high school biology instructors. Throughout Chapter One, I reflected on my own journey to this point and investigated where my desire to create a meaningful resource for those who may be in resource-poor settings comes from. In Chapter Two, I was able to look into what literature and research has been done to support and provide evidence for this resource. This allowed me to gain insight into the potential benefits and barriers in creating a resource like this. With this previous research serving both as a foundation and providing justification, Chapter Three was developed, outlining the development of the project and the format used in its creation.

Moving ahead to Chapter Four, I will reflect more on my Capstone journey, including highlighting the implications for this project, limitations in its creation and implementation, and finally where I see potential progress for it in the future. To frame this discussion, a summary of the literature is first going to be introduced, emphasizing the support and need for this project and inquiry styled lessons.

Summary of the Literature

Low-income schools are subject to numerous obstacles including a lack of financial support, with schools in high poverty districts receiving 15.6% less funding per student compared to schools in areas with less poverty (U.S. Department of Education, 2015). This problem was described in detail by Semuels (2016) in Connecticut, where districts spend on average $6000 dollars more per student in richer districts compared to poorer districts. This lack of funding impacts learning, with low-income schools showing lower graduation rates and test scores (Obidah and Howard, 2005). These effects are especially felt in the field of STEM, as the National Clearinghouse (2015) reported that from the class of 2008 just 6% of students from from high-minority, low-income high schools received a degree in STEM. This is in stark contrast to the 17% of individuals from less impoverished districts.

Furthermore, these schools suffer from high rates of teacher turnover. Hanushek et al. (2001) reports on this issue, with higher levels of teachers departing from schools with high proportions of students with low socioeconomic backgrounds. Teachers cite feelings of burnout, stress, and a lack of support as the driving forces (Johnson et al., 2004; Skaalvik & Skaalvik, 2007). Caygill et al. (2010) and the Trends in International Mathematics and Science Study (2010) conducted by New Zealand government, both emphasized the strain for supplies and resources as a major factor in teacher stress. This is especially true in rural schools, where science classrooms were reported by Ossola (2014) as not only lacking supplies, but not having a laboratory at all.

As the magnitude of theses issues are large and continuing to plague the education system, solutions are desperately needed. Large scale answers like funding restructuring, progressive initiatives, programs working to get low-income students into STEM programs, and reforming teacher training programs have all been proposed. However, these solutions take time and change and support is needed now. This Capstone project was created to serve as a tool for educators in resource-poor settings to immediately implement meaningful lessons into the classroom while the outside world works towards educational equity.

Incorporating inquiry into this resource was key, as the inclusion of this style of learning is increasingly making its way into science curriculums. It is also becoming more popular as it was the foundation for the recently released Next Generation Science Standards, due to its tie to higher order thinking. While the specific definition of inquiry-based learning has different interpretations, Jennings (2010) defines the root of this style of education as it being focused on the learner gaining knowledge through active investigation. It has also gained popularity due to its connection to engagement and it calling on students to think, hypothesize relationships, and give evidence like true scientists. Lambert (2007) tied inquiry to a range of skill sets including predicting and analyzing. Furthermore, Lazonder et al. (2016) in a meta-analysis of 72 studies found inquiry to have a positive effect on learning and performance. These effects are especially true in low-income environments where Seiler (2001) and Marx et al. (2004) found inquiry to be successful in decreasing the achievement gap in science classrooms.

This project incorporated guided inquiry as defined by Kuhlthau et al. (2015) as having targeted instructional interventions at each stage of the learning process throughout a lesson. As opposed to open-inquiry which is less structured, guided inquiry explained by Sadeh and Zion (2009) is when the learner is given a question and then led to a predetermined answer. Often there will be a point in the lesson where the instructor provides clarification to the students, in case they have not come to the understanding themselves. This allows for teachers to prevent misconceptions and misunderstandings. In the creation of my lessons, I made sure to incorporate a resource at the end of the lesson that provided clarification for students.

When making decisions in my lesson plan designs, I kept in mind some of the literature I read pointing out weaknesses in inquiry style approaches. For example, the incorporation of this clarification at the end of the lesson was important to me as many critiques for inquiry cited misinformation and misunderstandings as a weakness. Furthermore, inquiry is criticized as lacking guidance and organization by Mayer (2003) and Markham (2013). My web-based inquiry lessons provide a lot of support as learners are given clear directions throughout the entire learning process.

Another finding from my literature review that I took careful consideration over when completing my lesson plans and website was what I found on technology and inquiry. Support for my project and the availability of computers is demonstrated by the report from the U.S. Energy and Information Administration (2016), citing that nine out of ten schools have computers for their students. Several educators have begun to see the potential of this, incorporating technology into daily classroom life. Many online curriculums have begun to spring up including WebQuest in 1995, ScienceWare in 1997, and then Biology Guided Inquiry Learning Environment (BGuiILE) created by Northwestern (Pryor & Soloway, 2000; Northwestern, 2009; Molebash & Dodge, 2003).

Chang et. al (2003) pointed out how vast the number of resources available online for science teachers are. In looking to this, I saw the potential for organization and utilization of these immense supply of ready made materials. While it is true that there are an infinite number of options, they lack organization and formatting into lessons. To me I saw this not as a challenge, but an opportunity to utilize what was available and make something meaningful. Shive et al. (2004) further supports this idea. These authors investigated what was available online for chemistry lessons and found that while there were lots of resources available for inquiry-based lessons, there were few pre-made inquiry lesson plans that used these free online resources. In creating this project, I took this potential and created web-based inquiry biology lessons and the website in which to access them.

Implications and Benefits to the Teaching Profession

Not only was the potential there for my project, with the abundant resources online, but also the desire as well. My research question and project come from a frustration with the education system, experience dealing with the additional stressors of working in a low-resource school, and passion to make high quality and engaging learning more accessible to all students. While my project does not solve the higher-level, structural issues that have led to the dramatic educational inequity we see in the United States today, it is a grassroots solution. It is providing a means for high school biology teachers in resource-poor settings to engage their students with meaningful and inquiry-based lessons, without breaking their budgets or creating extra work to do so.

The implications of this project are a decrease in the burden of lesson planning and resource scavenging for teachers who chose to use it. In two studies, one done by McCarthy, Lambert, Lineback, Fitchett, and Baddouh (2016) and another by Kaufhold, Alverez, & Arnold (2006), the researchers found the that one of the main causes of stress on instructors was the availability of instructional supplies. By decreasing the burden of finding materials and developing curriculum on teachers, this website could in turn help with reduction of teacher burnout. Also, by making the website's format user-friendly and accessible, it doesn't require extensive time to use. The structure and design of the page was intentionally created to be simple and straightforward, ensuring teachers from all technological backgrounds were able to access and understand it. If instructors are confused, the webpage has a forum to contact me. I also created an email that I posted on the contact page. Not only can this contact forum be used to send questions or concerns, but I also encourage instructors doing similar work to share any content or ideas with me. This would allow the number of lessons to grow as well as evolve as suggestions are sent in.

Another potential implication for teachers who use this resource may be an increase in students' technological literacy. It is apparent with time that not only is higher education using technology in their institutions, but that this transition is trickling down to high school, middle school and even elementary schools. Getting students engaged on the computer early on, could help later in their academic careers when asked to complete using online resources or through platforms like Blackboard and Canvas. It is evident that this project, especially over time with the right promotion, has the potential to be a great resource, however it has limits in terms of its usability and application.

Limitations

While my project was created considering the background literature and with the best intentions, it is not without limitations. One of the limitations of my project is the number of standalone lessons I am able to create. Currently, the number of lessons I have created is four. Right now, the limiting factor is time, with me only being able to create high quality lessons so fast. I am addressing this by opening it up for others to submit ideas and lessons to me via an email and a contact forum on the webpage. This is one reason why it is crucial for me to promote my project as much as possible. I also plan on adding lessons myself over time so I can continue to increase the number of lessons available for instructors.

Another limitation is that my lessons are created using pre-made, free resources. I utilize only what is available already, can be found online, and is free. While there are many different resources out there that meet this criteria, it is important to emphasize that I am not creating the content, I am organizing it. Therefore, the material I use is not always tailored perfectly to what I would like or want in a resource. While I pull on as many strengths as I can from the different web resources available that I am able to find, it is not always a perfect match and sometimes may include information that is not perfectly aligned to the objective. When creating your own materials, it can be easier to ensure that spurious or extra content is not included in your lesson.

Also, whilst I try to support various types of learners, by including many kinds of media and ways to engage with the material, there could be more differentiation provided for the lessons. For example, teachers with learners in different stages or strengths may want to adjust lesson readings levels and make them more individualized. As I want to keep the lessons simple, I am reluctant to add additional links and make this part of the instruction more complicated, however it is something to keep in mind as I further develop my website and standalone lessons.

While my project has limitations, I hope to continue in the future to work to reducing them and making my project as understandable and useful as possible.

Future

Looking to the future, I think it is important I continue to build more lessons on the website. I may also make adjustments as I receive feedback from other instructors on their experiences with the lessons. Rather than a static forum, I hope to see the lessons change, grow and develop over time. As with any project, improvements can always be made and more lessons will be added. I have thought about an ultimate goal being to not only provide standalone lessons, but complete unit plans built using this web-based, guided inquiry approach. However, I think it is important to think about the implications of this. I do believe it is great to incorporate some of the web-based, guided inquiry lessons, especially where supplies are limited. I would be cautious about completely replacing hands-on lessons with this approach. Further research on my part would be needed to determine the potential effects on learning this change would have. I have seen the engagement hands on learning can have and wouldn’t want to lose this. I think the availability of these web-based inquiry lessons is important, but shouldn’t be the only way instruction is delivered in a classroom. A large piece of the future of this project will be the dissemination of it to outside sources. Eventually, I may invest in analytic data to determine its reach and potential other mechanisms for its advertisement.

Communicating my results

A crucial part of developing my website is making sure I am sharing it. This has been one of the biggest challenges for me is brainstorming ways to get my content out there. However, upon discussion with other instructors and advice from my content mentor some ways I plan on communicating my results are the following:

1. Create a Teachers Pay Teachers Profile
    a. This website offers a platform as an educational marketplace for instructors to distribute their materials to other instructors. Teachers can request a fee for their content or distribute it for free. I would offer my lessons free, directing teachers to my website.
2. Twitter and Social Media Accounts
    a. I plan on reaching out to friends and acquaintances who are instructors in the classroom to share the website and on their social media accounts.
3. Adding search functionality to my website
    a. In order to make my website searchable, I will need to submit it to search browsers like Google, Bing, Yahoo, etc. so instructors can find it when they are online looking for curriculum. By adding this functionality, my webpage will get more traffic and hopefully more use.
4. Submission of my Hamline Capstone Project
    a. Another small way I may be able to engage people in my website, is through the submission of my Capstone to the Hamline Capstone

database. As I won't be the last high school science instructor to take this class, hopefully other instructors taking this class, will find my resource when reviewing past Capstone projects.

5. Word of mouth
    a. Last but not least, I will be counting on word of mouth to spread my content. As instructors often opportunities like professional development to share and engage in discussion over content they find useful. I hope this will be the case with my project as I share my work with my friends who are teachers.

I will continue to share my project as much as possible. As a free-resource I think it could be of high value to not only instructors in resource poor settings, but to all high school biology teachers, whether it be for a day with a substitute or when struggling to plan a lesson. The more I am able to share my project, the more use it will get. In doing so, I will ensure that it is reaching the goals I had in place when creating it. It will make web-based inquiry lessons more accessible and give a solution to teachers who are struggling to get supplies.

Reflection of the project process and personal experiences

The idea for this project, as highlighted above, was inspired by my experiences in the classroom as an instructor. I found myself limited in my lesson delivery by the supplies I was able to get and defaulting back to the traditional lecture style and therefore a teacher-centered classroom. In this space, I felt trapped. This frustration, along with my teaching mentor from Teach for America demanding more of me as an instructor, I was pushed to think of ways to get my classroom student centered. My classes in Hamline also supported this line of thinking, encouraging all of the science teachers within the science teaching course to use inquiry in their lessons, to be student-centered, and to step away from the front of the classroom, the teacher centered approach. With these influences and out of the box thinking, I started making online inquiry lessons for my students. I knew that despite being short in supplies, I always had computers accessible for my students. I had heard from my colleagues similar gripes; lack of funding, leading to a lack of supplies and therefore struggles to implement inquiry lessons.

When starting the Capstone process, I knew I wanted to bring this idea, web-based inquiry lessons, to fruition on a larger scale. While I had done this process in my own classroom, it made me wonder if it could be shared. Looking back, I knew these lessons while time intensive in their creation on the front end, in the long run saved me much time and frustration. Not only did I not have to buy supplies, these lessons could be reused the following year with minor adjustments and improvements.

What I didn't know in delving into this project is what the literature said about my idea. In my searches, I saw a lot of research that supported my thinking and some literature that also challenged it. As a researcher, I knew how important it was to identify the barriers to my project. By finding these weaknesses, specifically in technology implementation and inquiry based lessons, I could better look to ways to support my project to minimize these barriers. This pushed me to be a more methodical lesson planner, making sure that I was answering the critiques that have been raised for technological implementation in the classroom and inquiry based lessons. This was done through using structured student packets and adding a resource that provided clarification on big concepts at the end of each lesson. This challenge, strengthened both the end-product of my project, as well as allowing for me to grow as a learner. The experience reaffirmed the importance of looking at not only the strengths of an idea but also the weaknesses. By knowing the full picture, not only can you troubleshoot where necessary, but can be better informed and receptive to feedback.

Another part of my thinking that changed during the course of this project was my expectations for what parts of my project would take the most time and energy. While I thought the creation of the website would be the most time intensive, this was not the case. After finding Weebly (Weebly, n.d.), this proved to be an easier portion of the resource development. Creating the student packets and compiling resources however took a great deal of time. Since I personally am not creating the subject content that is used in the lesson and student packet development, I had to form my student materials around these resources. In doing so I still had to ensure, I was meeting the objectives I had written. The breadth of material online available to reference in creating my lessons was truly how Chang et. al (2003) described from their research looking at chemistry lesson content on the web; so much material, but little organization. As a result, finding the best fitting resources for each lesson was time intensive. This process both required resilience and dedication, shaping my journey as a creator.

Another piece of my project that I struggled with was the contact forum. I really wrestled with the best way to make my website interactive and engaging yet ensure only the best content was shared. Message boards to me seemed messy and not something I could control. Monitoring their content was a more time intensive commitment than I could manage. Also, the fear of loss of control of the webpage was a concern of mine. However, when receiving feedback I was challenged on this and encouraged to provide an outlet for teachers to reach out with feedback, ideas, and lessons. Balancing the importance of getting feedback and advice with controlling the content released, I settled on both a contact forum and an email. This allowed for both sending in ideas, lessons and an easy way to share thoughts or concerns. This struggle was an important learning experience about who I am as a researcher. I discovered I am reluctant to let go of control. However I think in this project, through the creation of an email and contact forum, I have found a way to relax on this, while still ensuring the integrity of my resource.

The project provided some challenges, but overall really offered me the opportunity to grow through these obstacles. In writing the capstone paper, alongside my project creation, I have been able to express this process through my writing. Through this I grew not only in my knowledge of the literature, but became better at expressing myself and drawing conclusions from my findings. As a researcher, I am more flexible, as a learner more thoughtful, and as a writer more reflective.

Conclusion

Education is not a level playing field (Poesen-Vandeputte & Nicaise, 2014). When looking to the creation of this project, I have hoped to make that field a little more equitable. As low-resource schools are the hardest hit by the lack of educational funding, it is crucial to look for solutions not only that are higher-order and structural, but also that can be implemented now. This resource provides a simple and fast way to get more teachers involved in sharing and using inquiry-based, engaging lessons in high school biology classrooms.

In its creation, I have had both struggles and celebrations. I found myself working hard to create as many web-based, inquiry lessons as possible, while still ensuring they are of the highest value and include the best possible content. Designing a website initially challenging, but became easier after I found a user-friendly resource to get me started. I was able to create a simple and comprehensible lesson environment for my audience. Looking to the finished product, I can see how easily teachers will be able to find the supplies they need with just a few clicks of their mouse. Gone are the days of hair pulling and anxiety ridden moments where a teacher sits googling extensively only to find they need 16 bags of marshmallows, toothpicks, salt, baking soda, and a live lizard to complete the lesson they found.

In researching and creating this project, I have felt how creativity and experience can lead to creation of something that is meaningful. While I am no longer in the classroom, I was able to engage back to a topic that has continued to frustrate and plague me. I look forward to continuing to move it into fruition and share it with the outside world.

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