Technology-Enhanced, Inquiry-Based Learning in the Science Classroom

by

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Bachelor of Science, UBC, 2005
Bachelor of Education, UBC, 2006

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Abstract

The landscape of education is changing. Rote memorization and retention of facts is no longer useful in this technology-driven era. The British Columbia Ministry of Education recognizes these changes and is developing a new curriculum with an emphasis on more inquiry-based learning. This project examines how to best support inquiry-based learning with technology while teaching science. The specific types of resources examined include digital videos, simulation activities, and teacher guides for utilizing social media and mobile technologies. The resource is a curation of technology resources available for teachers to access and implement in a website format. The website is organized by individual science courses and the current curricular organizers. Currently, the website is available only to teachers in the Delta School District but there are plans to share it globally.

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Acknowledgements

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Dedication

I would like to dedicate this project to my late grandfather, Bishan Singh Nijjar. His constant presence in my childhood encouraged my passion and love of education. He brought my father here in hopes of a better life and I would not be whom I am today without his unwavering support and encouragement during all those critical years.

Chapter One: Introduction

Curiosity as the Driving Force

During my nine years of teaching experience, I have had the opportunity to teach a variety of courses at four different schools. I have taught in numerous departments, with many administration teams and colleagues with varying levels of collaboration. I am grateful for the opportunities which have contributed to the educator I am today. I look forward to the challenges to come which will mold me further as a teacher.

My current teaching assignment includes junior science and senior biology. After teaching mathematics full-time for the past four years, I was yearning to come back to teaching science. I would often go off on tangents during my classes when a scientific principle was discussed in math class. As much as I enjoyed teaching mathematics, I knew science was where my true passion lies.

The wonder and curiosity in science is what drove me to pursue a degree in biology. I enjoy learning about tangible things which can be investigated and have results that are easily replicated under similar conditions. I see that same sense of wonder and excitement in my students during discussions, videos, and laboratory experiments. Science questions the world around us, drives inquiry, and is able to help explain the phenomena we encounter in our daily lives. Science forces us to think beyond what we know and can observe and asks the question, 'why?'

This curiosity and wonder which is generated through science is what I wish to foster in my classroom. Through inquiry, students pose questions about the world around them, plan and carry out investigations to explore their interests and, lastly, form conclusions based on their findings. My goal is to facilitate this on a daily basis for my students.

The Shift to Inquiry-based Learning

With the advent of the Internet, information has become a readily available resource and is no longer the precious commodity it once was. Individuals are able to easily access information from the palm of their hand at any time and from anywhere. Thus, education which has been directed at the memorization of facts is no longer relevant in our technology-driven world. Students must be able to question the world around them and not simply accept information as fact. Students require skills to dissect the information being presented to them and apply it in an innovative way. This method of raising questions, analyzing information, gathering data, and forming conclusions is at the heart of scientific inquiry.

There has been a shift in education to place an emphasis on inquiry. The British Columbia Ministry of Education (2013) supports these beliefs with the new curricular documents. They have highlighted the importance of broader prescribed learning outcomes and less on multiple specific achievement indicators. Learning is to become more student-centered and less teacher-driven. The goal is that students acquire skills and have a broader understanding of topics. There is a reduced emphasis on rote memorization of facts. These universal skills can then be applied to a number of different scenarios rather than having an in-depth understanding of a particular concept. The British Columbia Ministry of Education further highlights the importance of critical thinking and problem solving skills which are key components of inquiry.

This shift towards more inquiry-based learning will help equip the next generation with the skills needed in an ever-changing world. Students engaging in inquiry will have more ownership over their learning which will foster engagement. Learners will have the opportunity to explore topics they find personally relevant. More student-directed investigations will help facilitate more meaningful learning experiences. These students will also approach new challenges with reduced apprehension since they will have the skills necessary to overcome a variety of obstacles.

Technology Integration

> *"When the Internet can provide easy access to entertaining conspiracy theories and pseudo-scientific articles, there is more need than ever to enable young people to engage in rational scientific discourse and practices." (*Anastopoulou, Sharples, Ainsworth, Crook, O'Malley and Wright., 2012, p. 252*)*

Technology has become more and more pervasive in our daily lives. It has altered the way we live and communicate with one another. Technology is no longer merely a tool to access information; it has replaced or enhanced aspects of our daily life. It is used to keep track of appointments, check the weather, get directions, listen to music, shop and pay for items, and communicate with one another through text, pictures, and video. That is but a mere snippet of some of the daily uses of technology. The British Columbia Education Plan (BC Ed Plan) recognizes the significance of technology to youth in today's world and its transformative powers: "In 21st Century Learning, students use educational technologies to apply knowledge to new situations, analyze information, collaborate, solve problems, and make decisions" (British Columbia Ministry of Education, 2015). School boards have also acknowledged its importance and have responded by providing Wi-Fi access for students while in school and increased bandwidths to accommodate multiple digital devices. Thus, it is valuable to investigate ways to meaningfully integrate technology to enhance education and learning for students.

Teachers are at the forefront of technology integration in the classroom. Novice and experienced teachers alike have integrated technology to varying degrees based on a variety of factors. The literature reviewed in Chapter 2 will discuss these factors in detail. For some, the technology has merely replaced a previously used piece of equipment, for example a PowerPoint presentation in lieu of a collection of overheads; whereas for others it has created meaningful and unique learning experiences which would otherwise not have been possible without the technology piece. Many successful examples of technology integration to enhance inquiry will be discussed in Chapter 2. My research project will investigate these experiences and document the types of technology which promote inquiry-based learning.

Introduction to the Project

Background of the problem. Educators currently use technology to supplement education in the classroom and beyond to varying degrees. Some educators are uncomfortable with new technologies due to concerns about learning how to implement a new device or application and troubleshooting. This fear of the unknown may prevent some educators from ever trying a new piece of technology altogether. There are some educators who have teaching strategies which they have perfected over the years. They may not feel the need to venture out on to new unexplored territory. In contrast, there are those who are eager to seize the opportunity to pilot new devices and provide feedback for better classroom implementation. These individuals are willing to take risks and do not let the fear of failure govern their decisions. Regardless of the degree of technology integration, much of what occurs in the classroom is not shared among colleagues. The potential successes and failures are often not discussed beyond the learning space or individual school. This newfound knowledge remains in the confines of the classroom only to be lost.

Although technology integration has become more commonplace in our classrooms, it is often only a tool which replaces a previously effective tool. The overhead projector, for example, is perfectly effective at enlarging text and images onto a projected screen. PowerPoint presentations are also effective at the same task. However, they also have built in capabilities which provide even more functionality in the classroom. Teachers are feeling more pressure to be utilizing technology but may not be doing it effectively to actually promote inquiry among students. They may be unaware of how best to make use of the tools available to them. Through collaboration and professional development, educators are more likely to become equipped to successfully overcome these barriers.

The transformative powers of technology in our daily lives are evident. With this technology available to us, it is imperative that educators apply it in meaningful ways to enhance learning and engage students. However, some educators are still only utilizing these tools at a basic level to substitute and augment learning via technology. The true transformation of education will stem from redefining tasks which were previously inconceivable without the technology and modification to allow for the redesign of tasks (Schrock, 2015). I am addressing the problem of finding effective ways to integrate technology to promote scientific inquiry and share these ideas among educators with the opportunity for collaboration.

Purpose and research questions. The purpose of my project was to look at different methods, applications, programs and technological devices which will enhance learning and promote inquiry in science for students. My goal was to create a website which can be used by educators in the Delta School District looking to incorporate technology in a meaningful way into the classroom. Although the resource will be specifically addressing technology-enhanced scientific inquiry, I hope that it will also serve educators wishing to incorporate technology-based inquiry in all subject areas and grade levels.

The questions I will be addressing through my research project are:

1. Does technology integrated into the learning experience promote inquiry in science education?
2. What technological programs/applications/tools/devices encourage and enhance inquiry in the Science classroom for students?

Project description. I am approaching my project from a constructivist learning perspective. I am incorporating the prior beliefs and experiences of educators and students to promote inquiry in science education through the use of technology. I have developed a website which will be accessible to all teachers in the Delta School District. The district is participating in an initiative to compile resources from a variety of sources to support teachers. The website is a WordPress site hosted by the district. It is an extension of the current DeltaLearns website and has been named “Tool Kit for Innovative Teaching and Learner Success.” The objective is to provide a source of information on a variety of topics for the professional development of teachers in the district. Some of the topics include: assessment, social and emotional learning, learning design, and inquiry among many others. My contribution, as part of this project, will fall under the heading of scientific inquiry. The website has been launched and shared among teachers throughout the district.

My focus for the project is technology supported inquiry-based learning in science. The website will serve to provide teachers with information and resources to implement technology to enhance inquiry in the classroom. I have provided links to useful websites providing examples and support of inquiry-based learning in science. Information has been provided for teachers to set up the appropriate scaffolding for students which is a crucial component in the implementation of technology. I will also be sharing ideas of what I have implemented successfully in my own classroom. My goal is that the website will grow through collaboration between teachers in Delta. I hope it will engage other teachers within the district to share their experiences as well as try ideas presented by other educators. The website will be an ongoing accumulation of ideas, thoughts, and feedback from teachers within the Delta School District interested in inquiry-based learning in science.

This website will serve as a tool for teachers regardless of their comfort level or prior experience with technology. The website lists specific applications of technology which have been effective at promoting inquiry in the classroom. It will serve teachers from K-12 across a variety of subject areas but be geared primarily towards secondary science education. The website links to lessons and provides specific examples which can be adapted to serve learners of varying ability. The guide addresses what types of applications, devices, and programs are effective. Student handouts and tips for teachers are provided as part of the resource.

Chapter Two: Literature Review and Theoretical Framework

The literature being presented in this chapter will discuss the current understanding of scientific inquiry and technology use in the classroom. The theoretical framework of constructivism will be the guiding lens for this literature review. Inquiry is a critical component of learning, this is especially true in the science classroom. The process of scientific inquiry and its significance with respect to learning will be considered. Perhaps one of the most significant potential barriers to implementing technology and inquiry is professional development for teachers. Teacher perceptions of inquiry will be acknowledged as will the appropriate professional development necessary for the successful implementation of inquiry-based learning in the classroom. In this literature review chapter, factors necessary for the seamless integration of technology into the classroom will be presented. The potential barriers to the seamless integration of technology will be considered. Research indicates that in order to successfully integrate technology, the access to a high level of technology across all learning spaces is required (Song, 2014). Many studies have demonstrated successful integration of technology to enhance inquiry in science education (Chang, Quintana, & Krajcik, 2010; Lee, Linn, Varma, & Liu, 2010; Code, Clarke-Midura, Zap, & Dede, 2013; Donnelly, Linn, & Ludvigsen, 2014, Song, 2012; Song, 2014). The general findings of these studies will be discussed and the further research suggested by the authors.

A literature search was conducted using the keywords: science, inquiry and technology. The University of Victoria library catalogue was used as well as Google Scholar and ERIC. A limitation of scholarly, peer-reviewed articles from 2010 to 2015 were considered for the purposes of this literature review.

Theoretical Framework

Constructivism. A useful theoretical framework for inquiry-based learning in science is Constructivism. Wheatley (1991) states Constructivism is a learning theory, which asserts that knowledge is not passively received but is actively constructed by the learner. In the constructivist classroom, education is characterized by the role of the teacher being that of a facilitator. Students actively construct their own understanding based on their existing knowledge (Savasci & Berlin, 2012). In constructivism, there is an emphasis on the knowledge, beliefs, and skills that a learner brings to the experience (Garbett, 2011). The life experience and prior knowledge of the learner play a significant role in the interpretation of the meaning and reconstruction of the experience.

Liu and Chen (2010) define learning in the constructivist classroom as the “cycle of questioning, interpreting, and analyzing information, combining information and thinking to develop, build, and alter meaning and understanding of concepts, and integrating new understandings with past experiences” (p. 65). Constructivism is a helpful framework when considering inquiry-based science teaching (IBST) because both stimulate active construction of knowledge (Bächtold, 2013). Learning of new knowledge through a constructivist approach requires active involvement of the learner. The learner will construct this new knowledge based on previous knowledge (Bächtold, 2013). Hirtle (1996) defines one of the goals of constructivism as providing a critical learning experience for students by opening boundaries through inquiry and not accepting prevailing knowledge without question. Scientific inquiry and constructivism both share similar virtues including questioning, analyzing, interpreting and forming conclusions;

therefore, constructivism is a useful framework when considering inquiry-based learning in a science classroom.

Scientific Inquiry

Scientific inquiry is at the heart of discoveries we rely on each day for the advancement of our society. Inventions such as the telephone and electricity would not have been possible without inquiry which is defined as "a process of posing questions, gathering and analyzing data, and constructing evidence-based explanation and arguments by collaboratively engaging in investigations to advance knowledge and develop higher order thinking skills" (Sandoval & Millwood, 2005).

The authors demonstrate that scientific inquiry is a process involving a number of steps. Rivera, Maulucci, Brown, Grey and Sullivan (2014) break down scientific inquiry into four phases: exploration, investigation, presentation and application. Fundamentally, the literature shows that scientific inquiry occurs when questions are raised through exploration, and predictions are made with relevant evidence. An investigation is conducted based on the prediction. Finally, the data is analyzed and presented. Conclusions are developed based on the findings of the inquiry.

Inquiry-based learning is a student-centered learning approach in which students work collaboratively in an active and social process to construct new meaning from their learning (Raes, Schellens, & De Wever, 2014). This approach is in contrast to traditional methods of teaching and learning which focus on the transmission of knowledge from teacher to student and thus rely heavily on rote memorization of facts. This traditional method also presumes that the teacher is all-knowing and the learner is but a mere vessel to be filled with information.

For the purposes of this research project, the definition used for inquiry-based learning (IBL) will be the one proposed by Ahmed and Parsons (2013): “Inquiry-based learning is an educational approach in which learners can get knowledge through exploration and investigation within authentic settings, and may enhance their critical thinking skills” (p. 62).

Teacher Professional Development

In order for strategies to be effectively implemented in the classroom, appropriate scaffolding and teacher training must occur. A teacher’s beliefs about education may not necessarily be reflected in their teaching practice without adequate training and support (Savasci & Berlin, 2012). For teachers to successfully incorporate inquiry in their classrooms, they must be equipped with the necessary strategies and techniques for effective implementation (Savasci & Berlin, 2012). Similarly, if technology is being used to enhance inquiry, teachers must not only have a strong grasp of the technology itself but also be skilled at troubleshooting. Therefore, successfully implementing technology into the classroom to enhance inquiry is two-fold. Firstly, teachers must be able to enhance instruction to promote inquiry and, secondly, be able to integrate the technology effectively to supplement learning.

Many student teachers struggle to teach science largely due to having a poor grasp of the content material and negative attitudes towards teaching science (Garbett, 2011). Teachers of science must be well versed in science content knowledge, effective teaching and learning strategies, and be able to apply pedagogical knowledge to support their teaching (Garbett, 2011). Teacher education programs must prepare these preservice teachers by supporting them to plan, deliver, and evaluate science lessons with confidence in their abilities (Garbett, 2011).

Science teachers are encouraged to design learning activities to teach 'new literacy skills' (Campbell, Wang, Hsu, Duffy & Wolf, 2010). These skills provide students opportunities to use information communication and technologies (ICTs) to search and analyze information from multimedia resources, synthesize, create, report, collaborate, and communicate results with peers and their communities (Campbell et al., 2010).

Teachers form ideas about science instruction through various forms of evidence: their own perceived success of their teaching, their personal learning experiences, and students' performance on standardized and classroom tests to name a few (Davis, 2003; Little, 2003, as cited in Gerard, Varma, Corliss & Linn, 2011). It is crucial that teacher professional development programs consider teacher experience and pedagogy. Teachers develop a repertoire of teaching strategies and ideas as a result of experience, observation, and instruction. This previous experience is central to learning a new professional practice. "Teachers come to professional development programs with a set of views about the content they teach, the capabilities of their students, learning processes and pedagogy, curriculum materials, technology, and inquiry" (Gerard et al., 2011, p. 411). Thus, the experience and beliefs of the teacher will govern the effectiveness of the teacher professional development program.

Inquiry. Professional development practices can improve inquiry outcomes through inquiry workshops, curriculum development experience, mentoring, and peer collaboration (Lee et al., 2010). A study conducted by Savasci and Berlin (2012) reported that teacher beliefs about constructivism were not necessarily consistent with classroom practice. Although teachers expressed a strong belief in constructivist pedagogy, classroom practice was governed by factors such as time constraints, class composition, and the pressures of standardized tests. The teachers in this study reported the importance of student-centered activities involving group work but more frequently practiced whole-class, teacher-centered activities in response to the constraints suggested (Savasci & Berlin, 2012). Frequently, inquiry-based teaching techniques require more time than direct instruction, thus, under the pressure of high-stakes assessments, teachers choose more traditional methods of learning for students (Donnelly et al., 2014). These findings support the need for more professional development and teacher training in IBL. Teachers may understand the benefits of inquiry-based practices on learning in a classroom but struggle to incorporate those beliefs into meaningful lessons.

Ideally, in an IBL environment, the role of the teacher shifts to that of a facilitator to help learners to brainstorm ideas, generate questions for exploration, plan and carry out investigations, collect data, gather information, and apply the information to analyze and interpret the data (Hakkarainen, Lipponen & Jarvela, 2002, as cited in Song, 2014). Findings from Savasci and Berlin (2012) suggest the need for more professional development and training programs to experience and implement inquiry-based lessons for teachers. In order to promote a consistency between espoused beliefs and classroom practice, further participation in classroom observations and reflection with teachers and colleagues must occur (Savasci & Berlin, 2012).

Lee et al. (2010) emphasize the need to further investigate specific professional development practices and teacher experience in order to design professional development programs which support teachers to overcome potential barriers to implementing instructional strategies based on sound learning pedagogy. Successful professional development programs will engage teachers in IBL activities and provide solutions to address issues such as time constraints and standardized tests. Teachers appreciate insights from other colleagues who have successfully engaged students in IBL (Donnelly et al., 2014).

Technology to promote inquiry.

"It is time we shifted our focus from technology integration per se, to promoting technology-enabled learning" (Ertmer & Ottenbreit-Leftwich, 2012, p. 175).

Technology in itself may be challenging for teachers to incorporate into meaningful lessons to promote critical thinking. It requires the teacher to have a thorough understanding of the technology itself and the knowledge to overcome potential obstacles students may encounter while using the technology (Gerard, et al., 2011). Furthermore, technology integration also requires seamless integration with the content material. If the technology is being used to merely engage students and does not support learning of curriculum, it will have minimal value to teachers. Gerard et al. (2011) noted that few preservice programs prepared teachers to use technology-enhanced materials to support inquiry. Since technology is continually evolving, professional development programs are often not able to keep pace. As such, many science teachers have "limited experience implementing instructional technologies designed to enhance students' conceptual understanding" (Gerard et al., 2011, p. 410). Furthermore, studies have shown that "professional development programs can improve instruction when they immerse teachers in inquiry investigations" (Gerard et al., 2011, p. 409). The effectiveness of the technology depends more on the teacher's goals, pedagogy and content knowledge than the technology itself (Gerard et al., 2011).

There is ample evidence to support the use of technology-enhanced instruction over typical textbook-based materials alone (Chang et al., 2010; Lee et al., 2010; Code et al., 2013; Donnelly et al., 2014, Song, 2012; Song, 2014). Studies have demonstrated the positive impact on student learning gains on target scientific concepts as a result of the technologies implemented (Gerard et al., 2011). However, the appropriate scaffolding must be in place for students to be comfortable with the technology itself. Inexperienced users will have more difficulty than those fluent with the technology (Lee et al., 2010).

Potential Setbacks to Technology Integration

Usability and functionality. The usability and functionality of a technology will ultimately determine whether it is appropriate for teaching and learning (Code et al., 2013). If students spend more time learning how to use the technology than actually applying it to learn, this will impede learning (Ahmed & Parsons, 2013). The effectiveness of it as a tool will ultimately depend upon teachers' and learners' choices and perceptions (Code et al., 2013). The more complicated the technology is to learn and implement, the less likely it is to be used in the classroom. Learners and teachers alike will be less drawn to complicated tools which require significant troubleshooting skills. Learners are engaged through ownership and choice which can be provided via technology (Code et al., 2013; Song, 2014). Learners showed preference for technology-enhanced instruction over traditional methods when they were provided choice and control through the application (Code et al., 2013; Song, 2014; Donnelly et al., 2014). It is necessary however, that the technology is able to provide a balance between providing too much guidance, becoming formulaic, and providing insufficient guidance causing confusion and disengagement of learners (Donnelly et al., 2014). Designers of such technologies must take these factors into consideration to design the optimal learning experience for students.

The findings of Gerard et al. (2011) reported that teachers faced a variety of technological challenges in the first year of implementation within a professional development program. These challenges included: the setup of any specialized equipment, availability of technology hardware and software in schools which was current, and issues with the Internet involving security blocking of sites and connectivity (Gerard et al., 2011). Unforeseen technical 'bugs' also contributed to the list of challenges teachers faced. Additional time and training with the technology is required in order to overcome these challenges.

Time. A number of studies report time as a major obstacle for integration of technology by teachers (Gerard et al., 2011; Bubb & Earley, 2013; Curwood, 2013). This is important for both time for hands-on exploration with the technology in the classroom (Gerard et al., 2011), time for collaboration with peers (Curwood, 2013), and time for professional development (Bubb & Earley, 2013). The findings go on to report that in order for technology tools to be effective, professional development programs must be more long-term (a minimum of two years was suggested) than the one year published in the study (Gerard et al., 2011).

Accessibility to technology. A crucial component of technology-enhanced instruction is the technology itself. Publicly funded schools struggle to meet the needs of students and teachers (Sundeen & Sundeen, 2013). The rapid evolution of technology makes it even more challenging for schools to meet the changing demands of learners. It is imperative that schools not only have access to technology but to a functional standard of technology that is current with recent technological advances. Lee et al. (2010) show the importance of high quality school technology in the success of inquiry-based technology-enhanced instruction. The findings of their study suggest "students who used technology regularly for school work are more likely to succeed in technology-rich inquiry units" (Lee et al., 2010, p. 83). The effectiveness of technology-enhanced learning will be dependent on the seamless integration of technology use across all learning environments, namely home and school (Song, 2014). The successful integration of technology leads to more positive attitudes held by students, increased flexibility and interactivity and an overall ownership over learning for students (Song, 2014). These outcomes can only be achieved with access to technologies which are current and support learning.

The goal for many educators is to enhance science teaching and learning practices so that students develop scientific knowledge. Only then will they be able to understand and engage, as informed citizens, with science-based issues (Scanlon, Anastopoulou, Kerawalla, & Mulholland, 2011). Campbell et al. (2010) advocate for an approach so students 'learn with' technology. The technology is integrated in such a way into the instruction so it becomes an indispensable tool for students to solve problems (Campbell, et al., 2010). This seamless integration of technology as an essential tool for learning is the goal for educators.

Research Findings on Technology-Enabled Inquiry

Studies reviewed by Song (2014) show that "students lack inquiry skills and need considerable support to become knowledgeable about content, competent in using inquiry skills, proficient at using technological tools, productive in collaborative work, and capable of articulation and reflection" (p. 51). In order for students to conduct inquiry investigations with technology, they must have previous experience with self-directed inquiry investigations and a thorough understanding of the technology being implemented. In the following section, research is reviewed on four major technology tools used to support inquiry in the science classroom. These are: mobile technologies, social media, simulations and virtual environments, and digital video.

Mobile technologies. There have been multiple studies that have supported technology-enhanced inquiry instruction (Chang, et al., 2010; Lee, et al., 2010; Code et al., 2013; Donnelly, et al., 2014; Song, 2012; Song, 2014). Other studies have considered the benefits of typical instruction in comparison to technology-enhanced inquiry. For example, Lee et al. (2010) reported findings that "well-designed inquiry science units can improve student understanding of complex topics across science courses and teaching contexts" (p. 85). Findings from various sources suggest that inquiry is enhanced through the use of technology (Lai, Khaddage, & Knezek, 2013). Song, Wong, and Looi (2012) conducted research experiments to determine the effectiveness of mobile devices to support scientific inquiry. The data collection included various student artifacts which were recorded via mobile technology (Song et al., 2012). Findings from this study led the authors to believe that through the 'bring your own device' (BYOD) initiative, the student understanding of fish anatomy was enhanced. Learning was seamless from school to the home through BYOD (Song et al., 2012). As a result of the inquiry, students developed more focused knowledge and gained deeper understanding of the fish anatomy (Song et al., 2012). The authors of this study observed that students had a sense of ownership and control over their own learning through BYOD. These observations were lacking in previous mobile learning research where they had to borrow a mobile device from school (Song et al., 2012). As a result of the study, the authors were able to identify several impacts of BYOD, including enhanced flexibility, mobility, and interactivity of learning to foster students' personalized learning (Song et al., 2012). Students' attitudes held very positive toward scientific inquiry which was supported by BYOD (Song et al., 2012).

Findings suggest that instruction with respect to inquiry was enhanced when technology was implemented more so than previous instructional strategies (Lee et al., 2010). Ahmed and Parsons (2013) also reported findings that mobile learning environments not only enhance learning performance for the duration of the study but also support retention of knowledge over a period of time. Thus, the literature suggests there is supporting evidence that students equipped with technology, such as mobile learning applications, will enhance their learning while performing science learning activities in comparison to those who were involved in methods involving traditional learning methods (Ahmed & Parsons, 2013; Lai, Khaddage, & Knezek, 2013). Long-term learning retention, however, still requires further study. There is insufficient evidence to indicate that learning with technology will result in long-term knowledge retention (Ahmed & Parsons, 2013).

Social media. Perhaps one of the most notable shifts technology has enabled is the multitude of ways individuals can communicate with one another. The use of social media among students has increased steadily over the years (Dabbagh & Kitsantas, 2012). Learners have shifted from being passive consumers of content to active co-producers (Dabbagh & Kitsantas, 2012). The affordances of social media allow for students to form personalized learning environments (PLEs) in which they develop an online identity and interact with peers to support their learning goals (Dabbagh & Kitsantas, 2012). However, these PLEs require self-regulation in order for learners to successfully achieve their learning goals (Dabbagh & Kitsantas, 2012). Learners must demonstrate motivation for learning as well as the skill of self-reflection in order to seek guidance from peers and/or instructors when necessary (Dabbagh & Kitsantas, 2012). A major advantage to PLEs is the ability for students to connect with one another from anywhere at any time. The immediacy of feedback is not possible in classes where interaction is solely dependent on face-to-face communications in class. When used effectively, these PLEs can become powerful learning communities which foster support and collaboration among peers.

Social media can also enhance motivation among students by increasing competition and collaboration among peers (Ciampa, 2013). Competition is regarded as an intrinsic motivator where individuals compete either to increase their own competence or increase their competence against one another (Ciampa, 2013). Student-centered activities encourage collaboration online by providing forums where students can share information and ask questions of one another (Ciampa, 2013). This collaborative property of social media often results in increased engagement of students as they are responsible for their contributions to a greater whole as opposed to their own individual work which will only be seen by the teacher. Thus, the student is not only accountable to the teacher but to their peer group as well.

Simulations/Virtual environments. Simulations embedded in virtual learning environments provide powerful tools for learners to manipulate variables and observe the outcomes (Campbell et al., 2010). The built-in capabilities of these simulations enable students to conduct scientific inquiry experiments without the constraints of time or space needed for the study in real time. Campbell et al. (2010) discuss one such simulation to observe plant population genetics over multiple generations by manipulating environmental factors such as temperature, soil type, wind, altitude, and precipitation among others. This simulation can be accessed by multiple users, each with their own avatars to interact, observe, and control the experiment (Campbell et al., 2010). The impacts of manipulating the previously mentioned factors can be observed in a short time frame compared to traditional methods. Alternatively, multiple experiments can be carried out concurrently to analyze the impact of one particular variable (Campbell et al., 2010). The data obtained from these experiments can then easily be used to generate charts and spreadsheets to analyze the data and form conclusions (Campbell et al., 2010). Thus, simulations can be used as powerful tools to support scientific inquiry.

Code et al. (2013) created a virtual learning environment for students to solve a problem: Save the Kelp! The goal for students is to determine why the kelp in Glacier Bay is dying by collecting data from the virtual environment and analyzing evidence. Students are required to form a conclusion based on their collected evidence to explain why the kelp is dying. This study was open-ended, as are most inquiry investigations, with no absolute ‘right or wrong’ answer. Some students struggled with this process having insufficient guidance and not knowing whether they were on the right track (Code et al., 2013). Other students quickly made a claim after collecting minimal pieces of evidence. However, students did report to enjoy the autonomy and choice provided by this virtual learning environment. This study supports the need for balance in providing sufficient guidance for learners without being overly formulaic as suggested by Donnelly et al. (2014). Code et al. (2013) also note that the majority of students participating in the study were strong in providing evidence for their conclusions, however, students had difficulty in reasoning from the evidence. This reasoning ability could perhaps be enhanced by the participation in further inquiry-based investigations.

Digital video. Effective instruction aims to incorporate different ideas such as dynamic visualizations (Lee et al., 2010). Dynamic visualizations are particularly effective when illustrating “phenomena which were too small or too large to observe in everyday settings” especially in topics concerning the chemical and physical sciences (Lee et al., 2010, p. 81). They were particularly helpful with a few of the topics such as: dynamic molecular interactions, electron distribution and movement, global warming phenomena, and the rock cycle and resulted in larger learning gains for students (Lee et al., 2010). Teachers commented that not only did understanding of the concepts being studied increase, but knowledge retention also increased because of the visualization . Students were able to refer back to the video while learning new concepts and integrate and apply previous knowledge: “...the students found it easy to revisit the digital video when learning new science content. This suggests that the visualizations have the potential to enable students to connect new science topics to their existing knowledge”

(Lee et al., 2010, p. 83). Consequently, digital video can result in greater learning gains when used for instructional purposes to illustrate concepts which cannot easily be observed (Tiernan, 2015).

Areas of future research. Many of the research findings suggest the need for future studies in the field of technology-enhanced inquiry in science. Gerard et al. (2011) suggest the need for more detailed evidence as to how technology-enhanced curricula is enhancing science instruction for students. They further recommend more long-term studies of professional development programs for teachers implementing inquiry techniques. This is due to the research from professional development programs which shows that teachers need time to develop skills in implementing inquiry (Gerard et al., 2011). Their findings also suggest that the values and beliefs of the teacher may have a greater impact on learning than a number of other factors. Thus, "the role of the teacher within Inquiry Learning Environments (ILEs) needs more attention" (Donnelly et al., 2014, p. 593).

Future research is also needed to explore "opportunities, tensions, and challenges of authentic science inquiry from student and teacher perspectives, as well as the long-term impact on students' achievement, sustained interest, and trajectories in science" (Maulucci et al., 2014, p. 1147). Much of the present research available and reviewed in this literature review has only been conducted using projects of short timelines. Long-term studies would provide evidence as to whether there is a correlation between inquiry-based learning and long-term student achievement and interest. One of the many challenges teachers face in the classroom is how to address a variety of learners with different ability levels and learning needs. The question remains whether this can potentially be addressed through technology (Raes et al., 2014). Future studies are needed to examine the role of technology with respect to different learner needs. Learners have the opportunity to use a variety of media such as sound, video, and simulations, however it is yet to be determined whether the affordances of these technologies can translate into increased learning for all regardless of ability.

Conclusion

Inquiry-based learning has long been regarded as a valuable, student-centered approach in education, dating as far back to learning theorists such as Piaget, Dewey, and Vygotsky among others. It draws upon constructivist learning approaches which require the integration of prior knowledge and experiences of the learner. Inquiry-based learning approaches are grounded in pedagogy which place the learner at the forefront of the experience to promote autonomous learning and create lifelong learners (Donnelly et al., 2014). Knowledge is no longer transmitted from teacher to learner but instead acquired through inquiry-based investigations designed and carried out by the student. The role of the teacher shifts to that of a facilitator in which the teacher acts as a guide for the student to pursue an area of interest and relevance to them. Thus, this form of inquiry-based, student-directed learning results in increased motivation and ownership (Chiang, Yang, & Hwang, 2014).

Scientific inquiry involves the process of posing questions, formulating a hypothesis, conducting an investigation, gathering and analyzing data and lastly, forming conclusions based on evidence. These all involve higher-order thinking and require problem solving, which are skills necessary for 21st century learners (British Columbia Ministry of Education, 2013). The youth of today, who must sort through the vast information available to them on their fingertips, need these skills to determine what is relevant and accurate.

In order for IBL techniques to be effective in classrooms, teachers need adequate professional development in inquiry and technology. A teacher may firmly believe in inquiry-based pedagogy, however, is unable to translate those beliefs into engaging and meaningful lessons for students. The constraints of time, class composition, and standardized tests often take precedence over meaningful learning (Savasci & Berlin, 2012). Teacher mentorship and collaboration in conjunction with professional development programs can help overcome obstacles to implementing inquiry (Gerard et al., 2011).

Although IBL has been advocated for as an approach in education across all curricula for years, for the purposes of this research project, the curricular content will be limited to that relevant for the teaching and learning of science specifically. The focus will be on BC Science Curriculum specifically from grades eight through twelve.

This literature review has demonstrated support for this project's focus on inquiry and inclusion of the commonly-integrated technologies today: namely, mobile technologies, social media, simulations and virtual environments, and digital video. For this project, a website will be created with resources available to teachers interested in implementing technology to promote inquiry in the science classroom. This approach of creating a website resource for teachers allows access to anyone interested in the topic. Tinelli and Luehmann (2008) suggest that teachers learn through actions with other like-minded science teachers. By connecting like-minded colleagues through social networking technologies, opportunities are provided to engage in meaningful discussions that contribute to learning (Tinelli & Luehmann). Thus, through this research project, a valuable resource will be created to help continue the discussion among like-minded science educators interested in implementing inquiry through the means of technology.

Chapter Three: A Website for Tech-Enhanced Scientific Inquiry

Teachers are constantly searching for ways to enhance student learning while increasing engagement. They develop a repertoire of strategies and build their toolkit over their teaching careers. Due to time constraints and various other factors, these ideas often go unshared and remain in the confines of the individual teacher's classroom. It is under this premise that the idea emerged to design a website to share elements of my own personal toolkit with other teachers along with an invitation for collaboration.

The purpose of this project is to create a website for British Columbia teachers with digital resources for use in the science classroom to enhance inquiry-based learning for students. These resources may include digital videos, simulation activities, and teacher guides for utilizing social media and mobile technologies to enhance inquiry-based learning in science.

The website has been designed with the intention of delivering digital resources that are both useful and easy for teachers to implement. The links have been organized according to specific science courses with accompanying sub-menus containing the units for each course. The following courses are currently included as part of the website: Science 8, Science 9, Science 10, and Biology 12. The selection of courses is based on the assigned teaching load and familiarity of the website designer. There is additional potential for future courses to be added as interest in the website grows and input is provided from other interested educators. Figure 1 is the home page of the website which can be found at: https://deltalearns.ca/sciencewithtech/ (access is currently limited to teachers in the Delta School District)

Each tab corresponds to a course. Sub-menus have been created under each course tab for each unit to provide a place to share digital resources as they become available (see Figures 5, 8, and 13). At the current time, not all unit organizers necessarily have links to active pages.

Figure 1. The home page for my Tech-enhanced Scientific Inquiry website.

About

An About page has been created to provide information for those interested in the website, about the author and the purpose of it (see Figure 2).

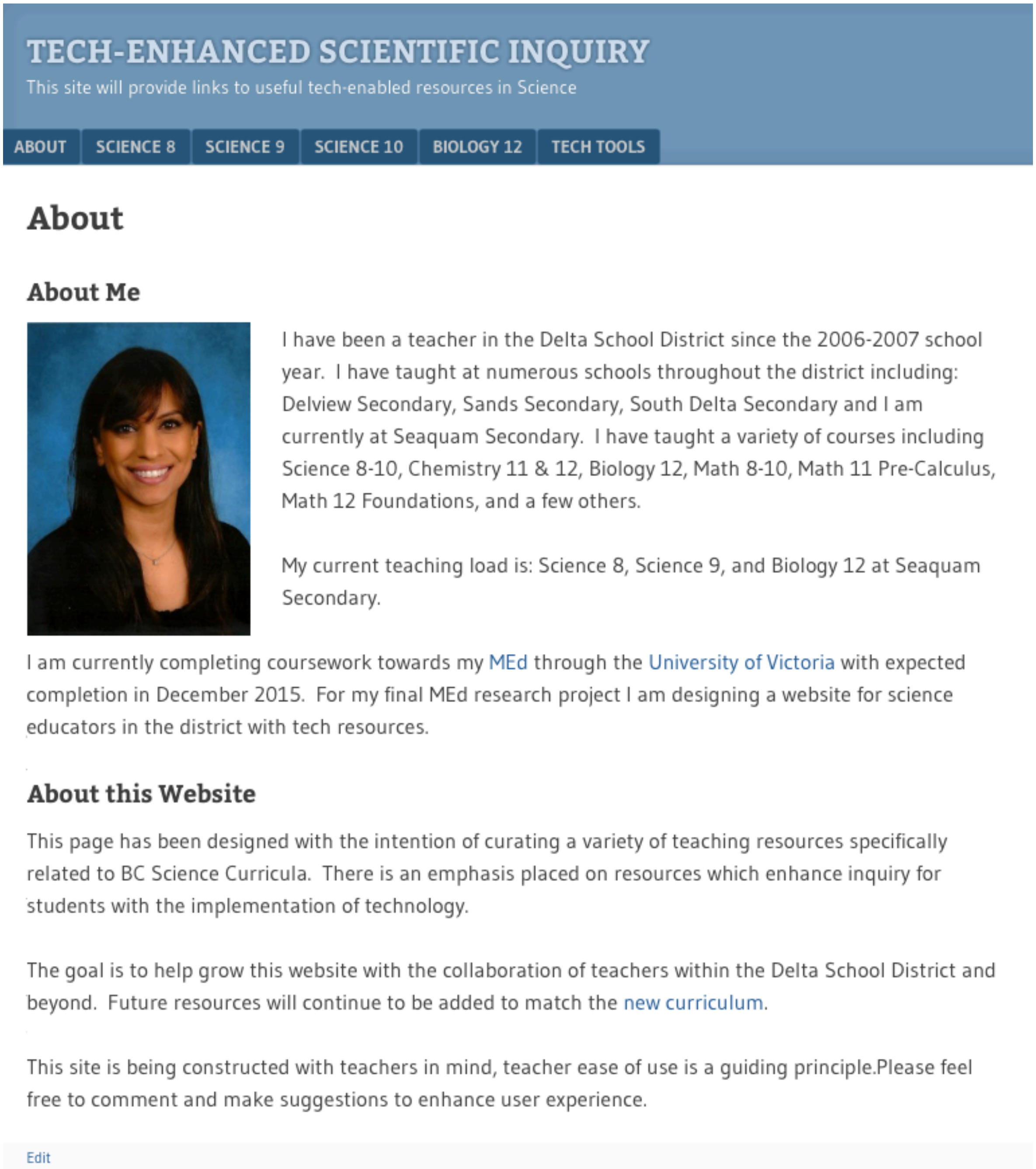


Figure 2. The 'About' page of my website.

Tech Tools

Each technological tool will also be indexed under the menu of Tech Tools to provide increased website functionality for teachers (see Figure 3). This feature is designed to increase the efficiency of access for interested teachers. The specific tool can easily be located by searching for the tool rather than the curricular organizer it falls under. Teachers with access to scientific probes, for example, will be able to efficiently find lessons designed to make use of the probes while teachers interested in sharing a video for students on a particular topic will be able to retrieve it quickly. In Figure 4, I share a screen capture of the Simulations page of my website and a list of all the indexed simulations.

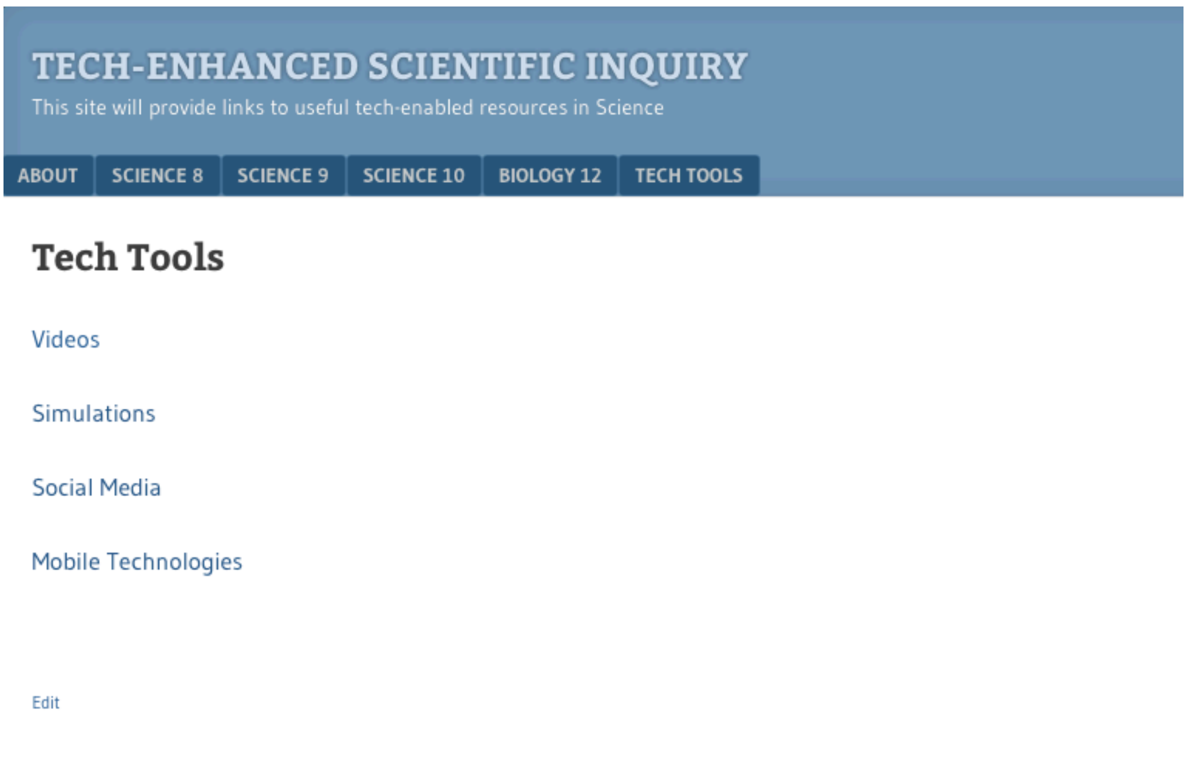


Figure 3. The Tech Tools page of my website.

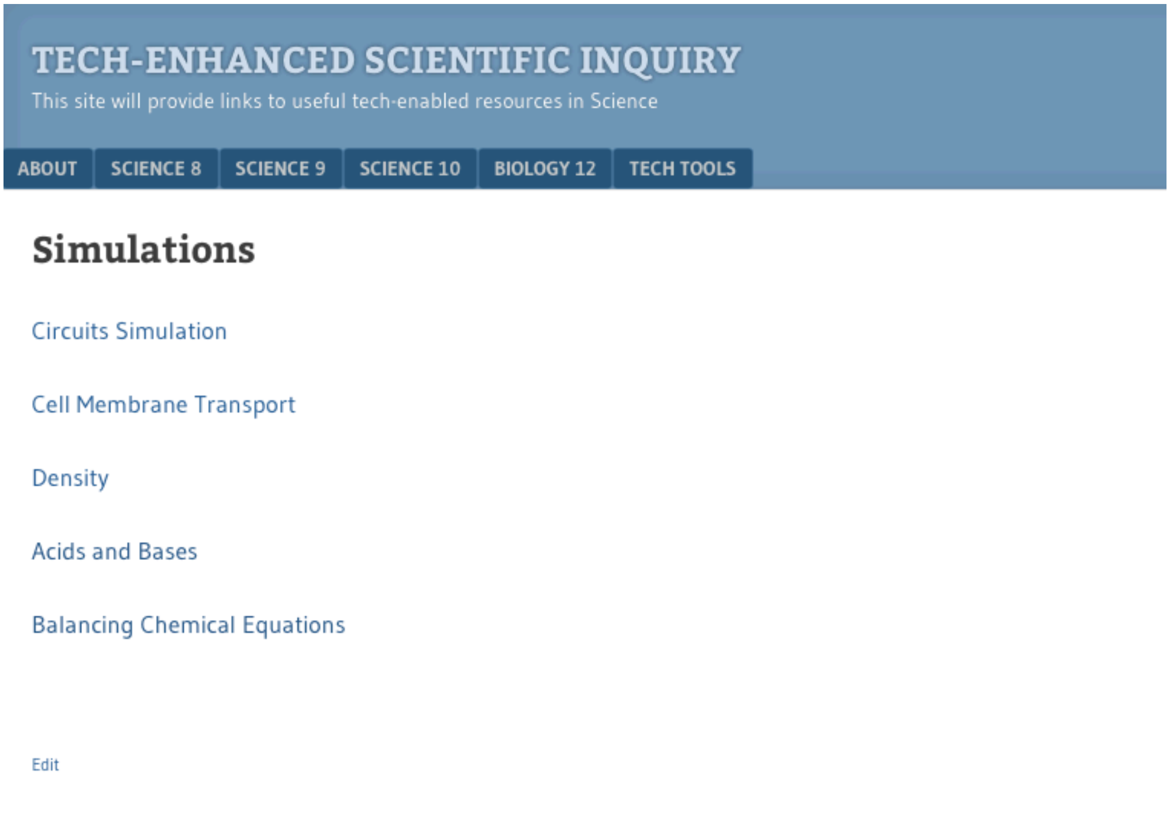


Figure 4. The Simulations page which is part of the Tech Tools page of my website.

Science 8

The Science 8 page of my website includes links to the corresponding unit organizers (see Figure 5).

Figure 5. The Science 8 page of my website.

Density simulation. For this simulation, students are able to move various objects into water and observe whether they sink or float (see Figures 6 and 7). There is also a scale and volume gauge provided in order to take the mass and volume of objects and calculate the resulting density. This simulation provides a hands-on approach as an alternative to using traditional lab equipment (Campbell et al., 2010).

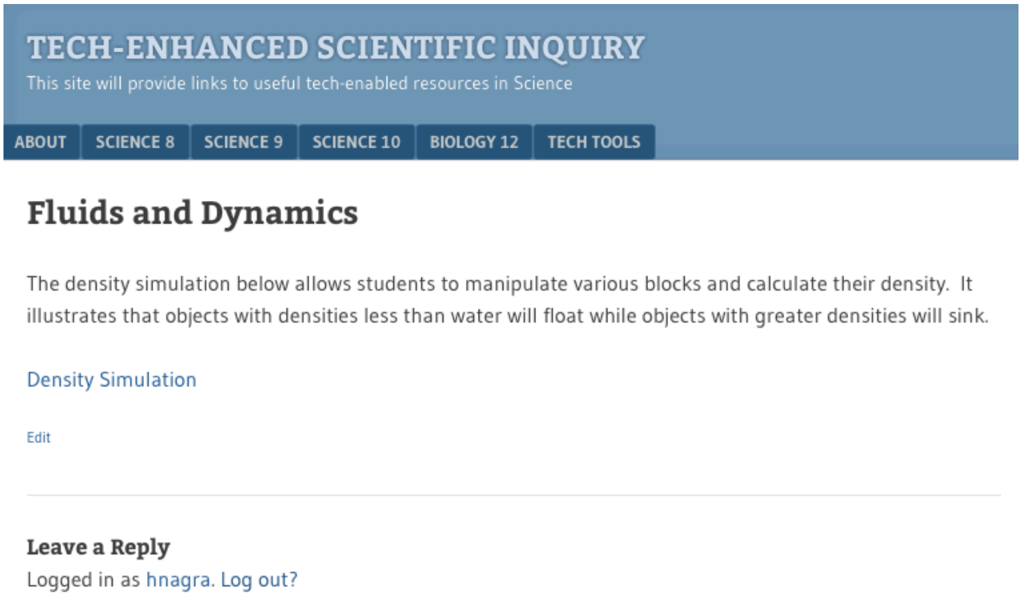


Figure 6. The Fluids and Dynamics page of my website with accompanying link to the simulation.

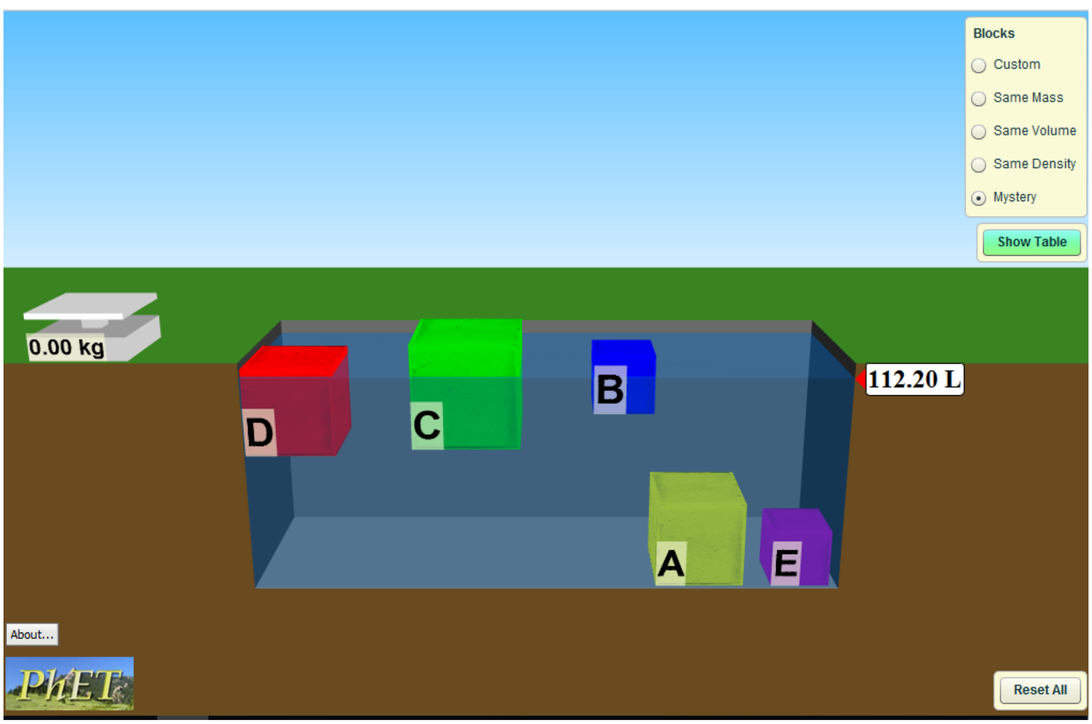


Figure 7. The density simulation website which can be found at: **https://phet.colorado.edu/en/simulation/density**

Science 9

The Science 9 page of my website includes links to the corresponding unit organizers (see Figure 8).

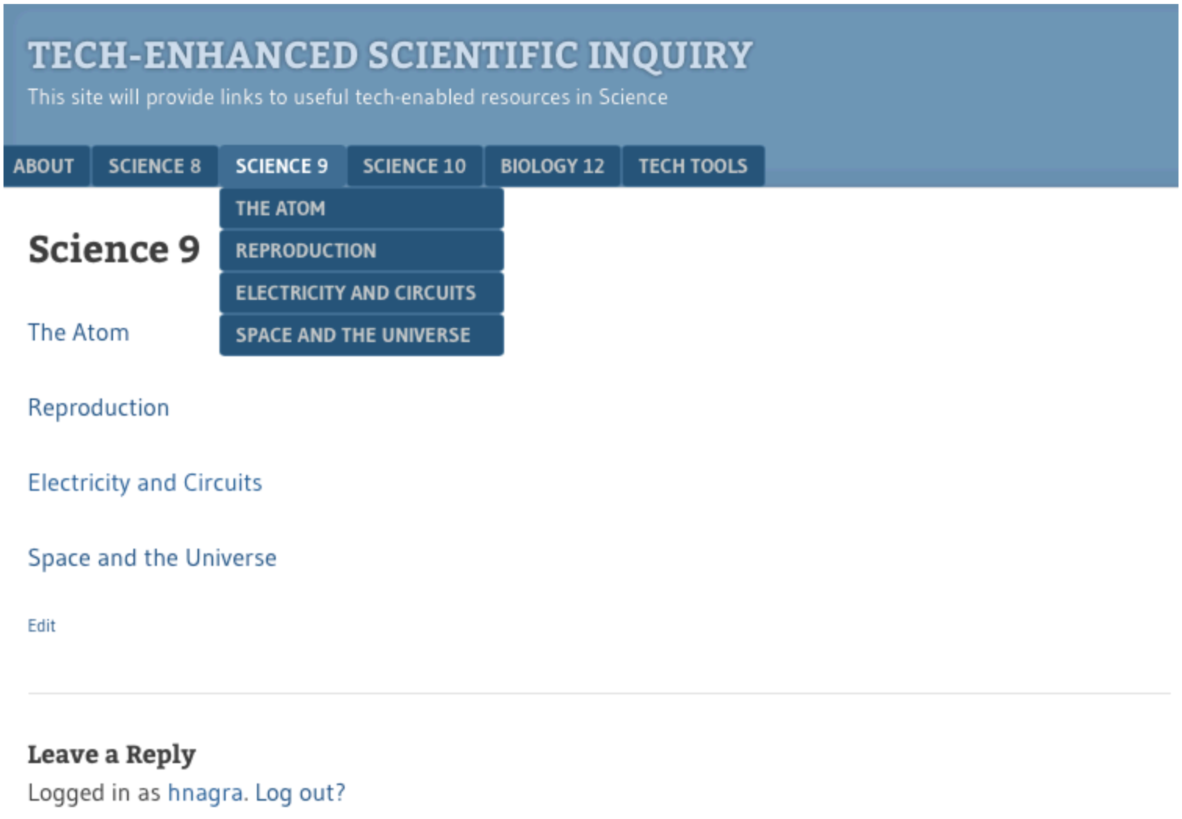


Figure 8. The Science 9 page of my website.

Circuits simulation. The circuits simulation website (University of Colorado, 2015) allows students to design virtual circuits in series and parallel and measure the resulting current and voltage readings (see Figures 9 and 10). This website is especially useful because students are able to manipulate, add, or remove individual components of circuits and view the impact on the flow of current which is difficult to visualize with traditional wires. This feature provides learners with control and autonomy over the experiment which increases student engagement (Code et al., 2013). Frequently equipment in schools may produce readings that are inaccurate due to misuse, age, and other factors. The simulation provides the opportunity to achieve the expected outcomes according to Ohm's Law without these constraints. The simulation also illustrates the importance of a broken circuit to students. If there is a faulty connection at any point in the circuit, the current will not flow and the circuit will not be complete. A student handout is also provided for teachers interested in providing a guided inquiry lab activity (see Figures 11 and 12).

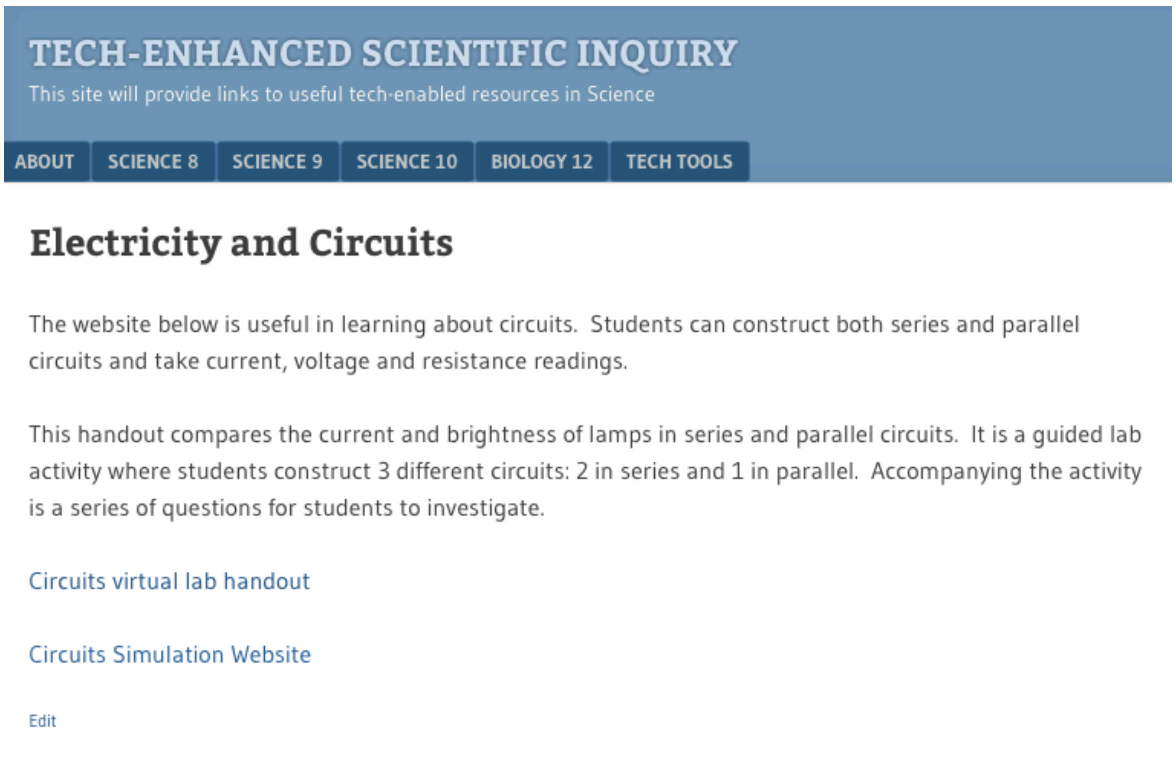


Figure 9. The Electricity and Circuits page of my website with accompanying links to the simulation and student handout.

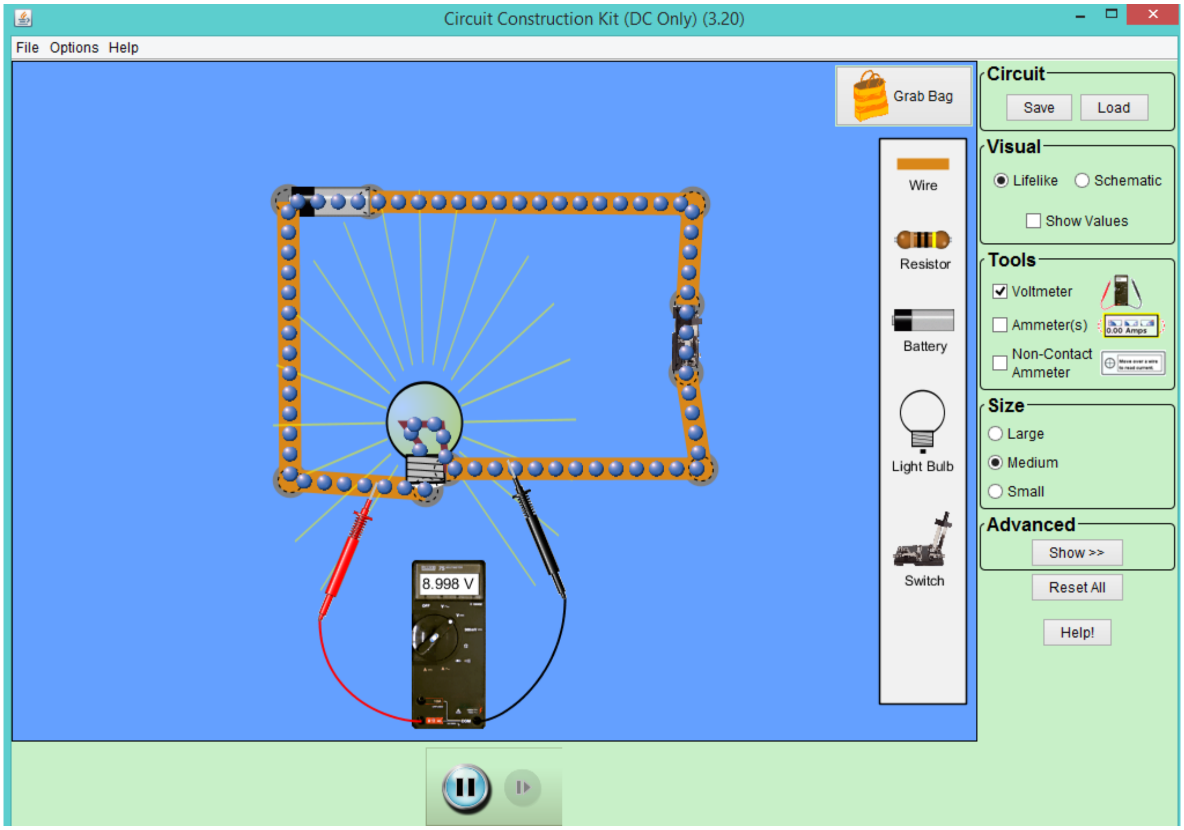


Figure 10. The Circuit Construction Kit Simulation website which can be found at: https://phet.colorado.edu/en/simulation/circuit-construction-kit-dc

SCIENCE 9

NAME: ___________________________
DATE: ______________ BLOCK: ______

ELECTRIC CURRENT

To complete this activity you will need to access the Circuits Simulation at the following website:

https://phet.colorado.edu/en/simulation/circuit-construction-kit-dc

You will need to have the appropriate version of JAVA in order to run the above simulation.

CIRCUIT #1:
Construct a circuit with 1 cell, 1 lamp, 1 switch, and an ammeter. Make a schematic drawing of your circuit below. Read the current on the ammeter and record it below. Notice the brightness of the lamp in order to compare with circuits #2 and #3.

Schematic Diagram: Current Reading: Brightness of lamp:

CIRCUIT #2:
Construct a circuit with 1 cell, 2 lamps in series, 1 switch, and an ammeter. Make a schematic drawing of your circuit below. Read the current on the ammeter and record it below. Notice the brightness of the lamp and record it. Disconnect one of the lamps in the circuit. What happens to the other lamp?

Schematic Diagram: Current Reading: Brightness of lamp: Other lamp:

CIRCUIT #3:
Construct a circuit with 1 cell, 2 lamps in parallel, 1 switch, and an ammeter. Make a schematic drawing of your circuit below. Read the current on the ammeter and record it below. Notice the brightness of the lamps and record it. Disconnect one of the lamps in the circuit. What happens to the other lamp?

Schematic Diagram: Current Reading: Brightness of lamp: Other lamp:

Figure 11. The first page of the Circuits Simulation Lab Handout.

QUESTIONS:

1. How does the brightness of 2 lamps in series compare with the brightness of 1 lamp by itself?

2. What happens to the current in a circuit if a second lamp is added in series?

3. How is the current reading in a circuit related to the brightness of the lamps?

4. What happens to the other lamp in the series circuit if you remove one of the lamps? Explain.

5. How does the brightness of 2 lamps in parallel compare with the 2 lamps in series?

6. How does the current reading in the circuit with lamps in parallel compare with the circuit with lamps in series?

7. What happens to the other lamp in the parallel circuit when you unscrew one of the lamps? Explain.

IN YOUR HOME:

8. If a light bulb in a lamp burned out in a series circuit, what would happen to the other lamps or appliances in the same circuit?

9. If a light bulb in a lamp burned out in a parallel circuit, what would happen to the other lamps or appliances in the same circuit?

10. How are the light and/or appliances best connected in your home – series or parallel? Explain.

Figure 12. The second page of the Circuits Simulation Lab Handout.

Biology 12

The Biology 12 page of my website includes links to the corresponding unit organizers (see Figure 13).

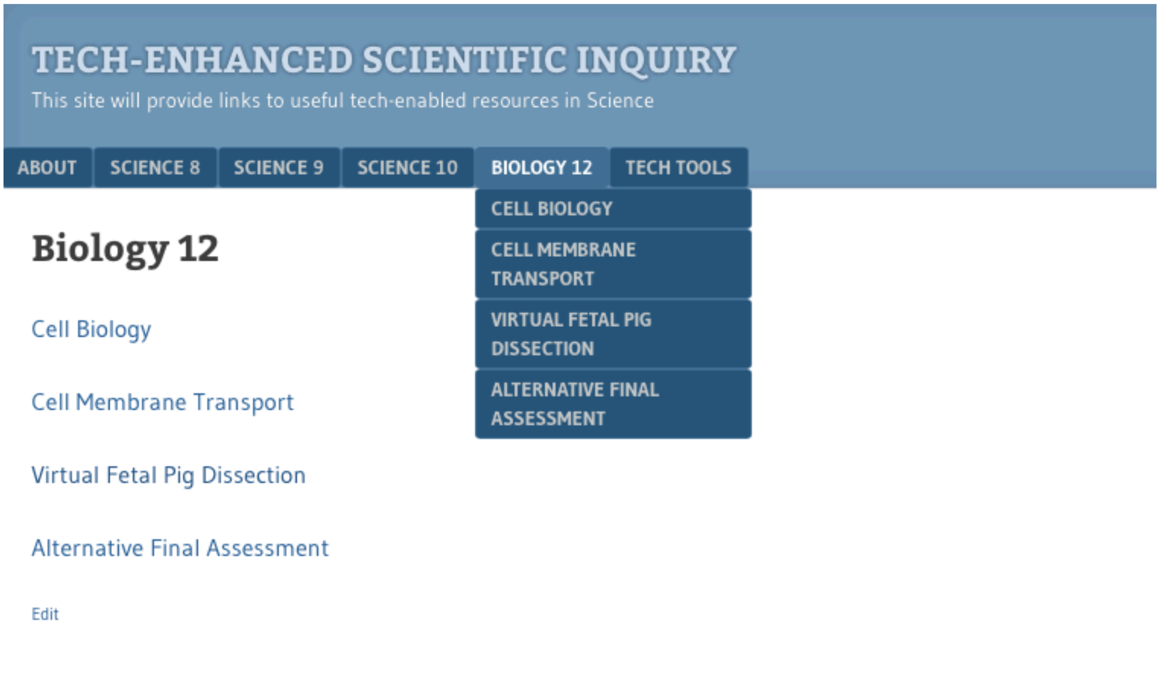


Figure 13. The Biology 12 page of my website.

Cell biology. The cell is difficult for students to visualize because of its microscopic nature. Teachers often have students view cells through the microscope to gain an appreciation of the relative size and structures. However, the still images produced by the microscope are insufficient to illustrate the dynamic nature of the cell and the interconnectedness of the organelles. Through the YouTube video added to the website (see Figure 14), the visualization provides students with greater learning gains by illustrating concepts which cannot be easily observed by traditional means (Tiernan, 2015). Students are able to appreciate how the cellular organelles work together through the visualization and form deeper connections.

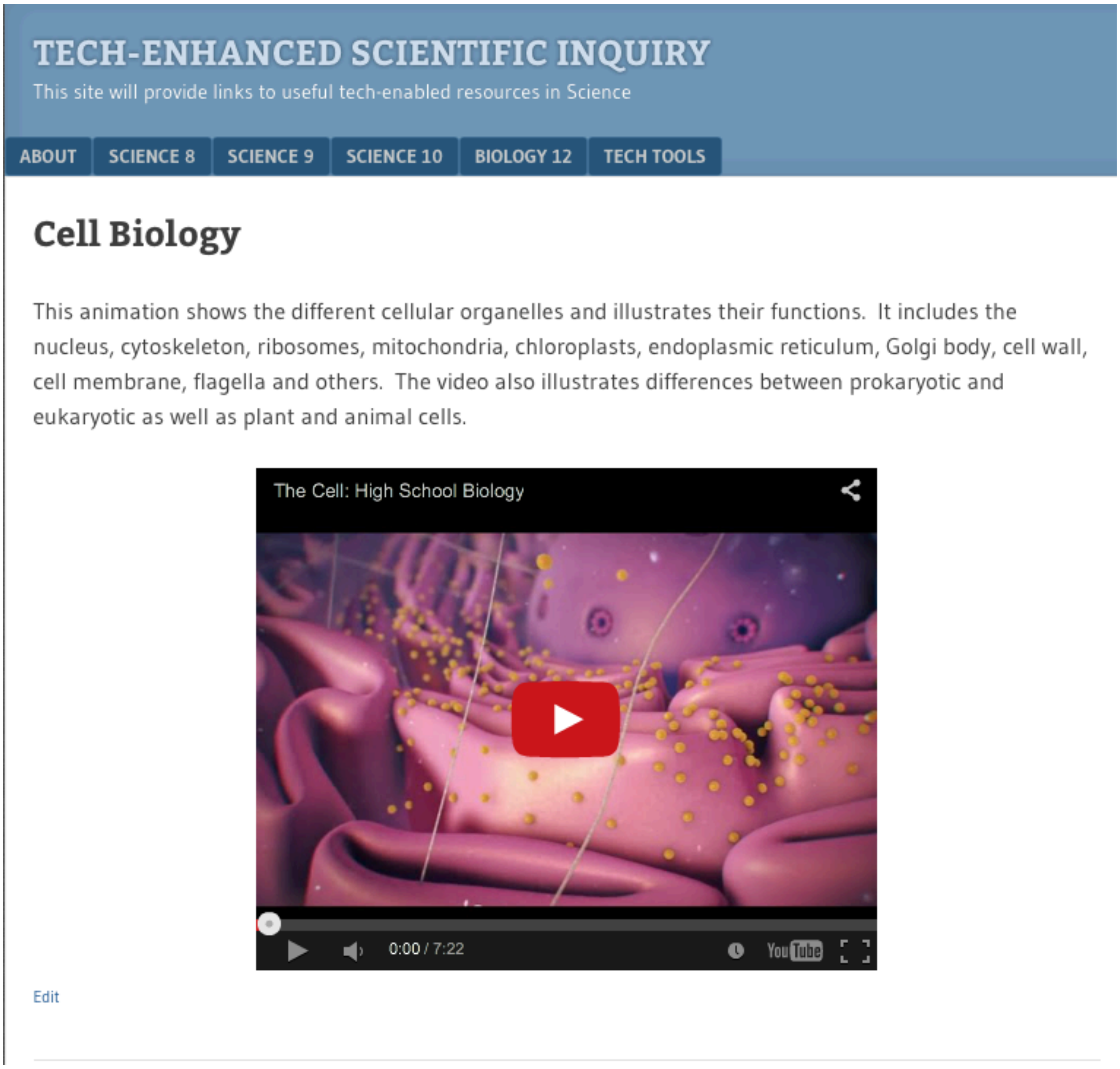


Figure 14. The Cell Biology page of my website.

Cell membrane transport. In Figure 15, I share a screen capture of the Membrane Channels simulation website. Through this simulation, students are able to manipulate the number and types of channels present in the membrane. They are also able to close or open gated channels and add varying concentrations of particles on either side of the membrane. The simulation can be sped up or slowed down to illustrate the movement of particles to students. This simulation is beneficial for students as it allows them to observe a concept that is difficult to visualize due to the constraints because of size in real-world situations (Lee et al., 2010).

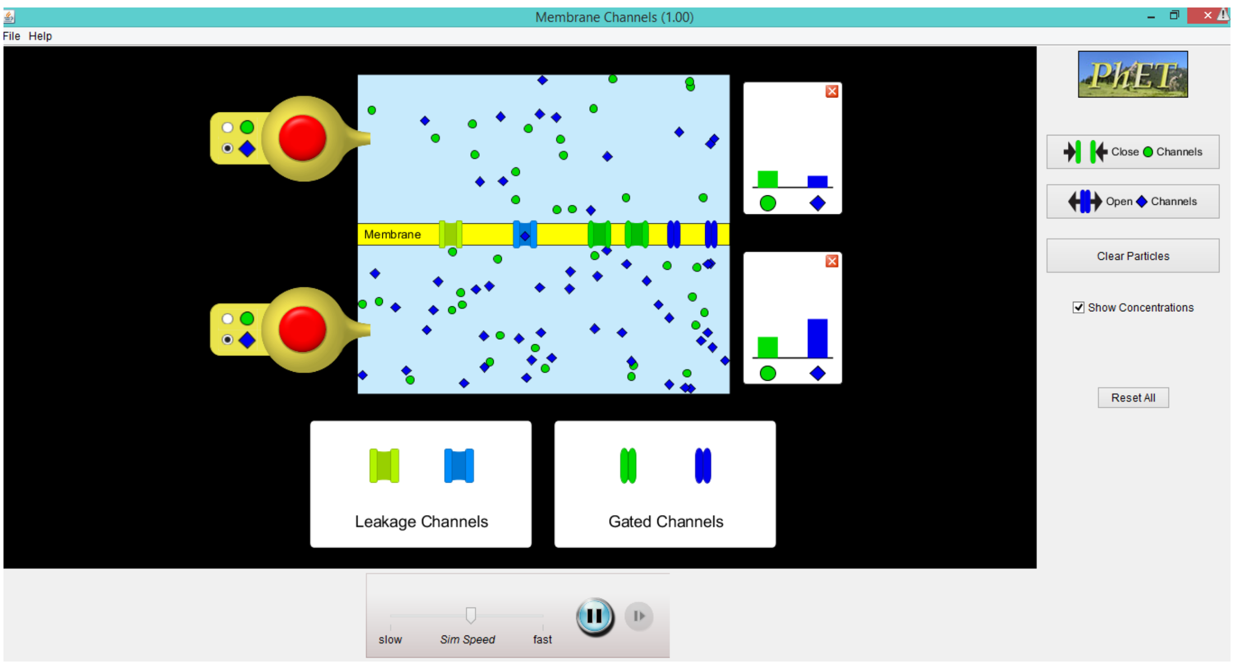
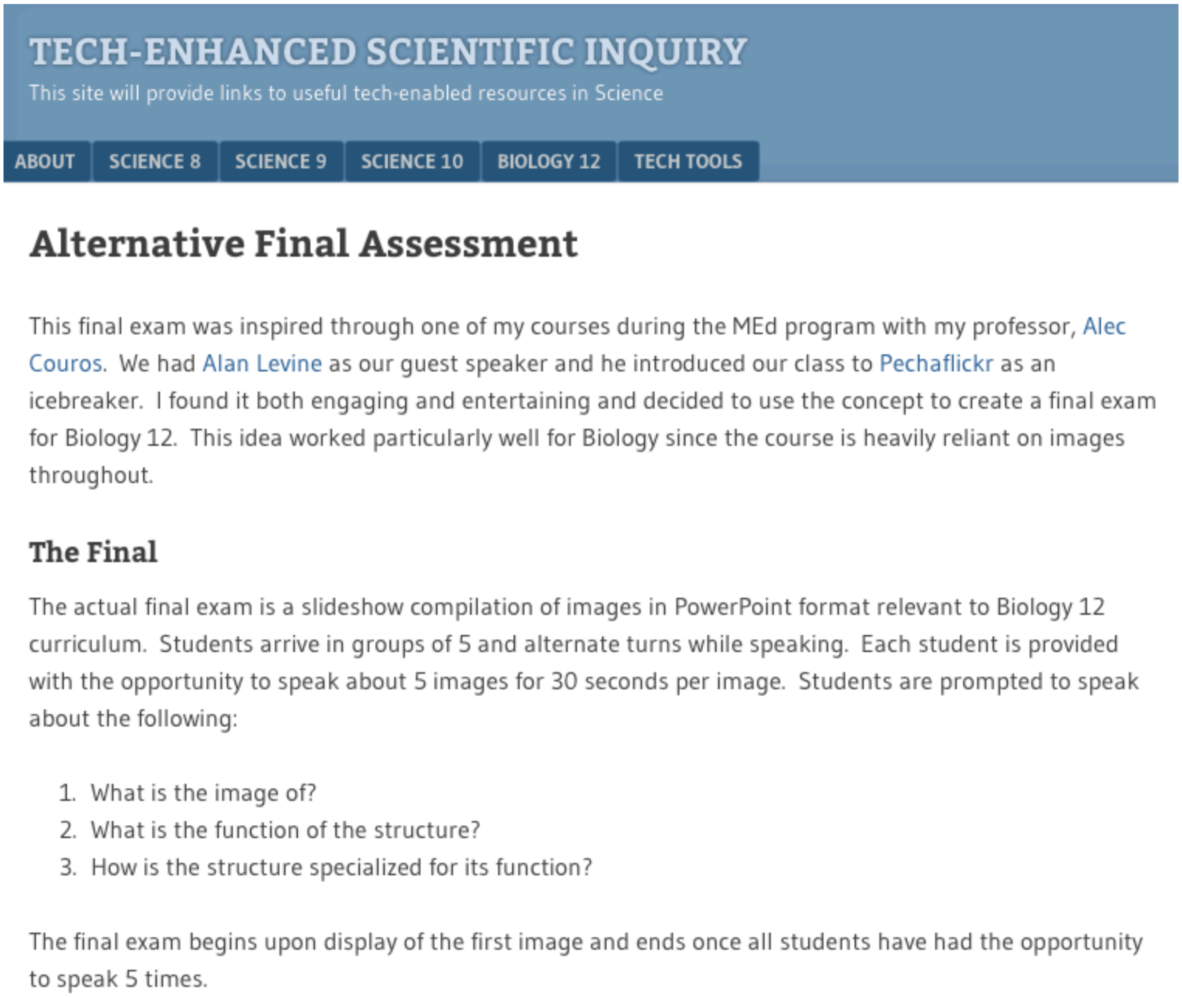


Figure 15. The Membrane Channels Simulation which can be found at: **https://phet.colorado.edu/en/simulation/membrane-channels**

Alternative final assessment. In Figures 16-18, I share screenshots of an alternative final assessment that I designed for Biology 12. This resource describes the preparation needed to run a 'Pechaflickr' (Levine, 2015) inspired final exam as well as some final thoughts for teachers interested in implementing the idea. The webpage includes links to additional resources to help support this process for the students and teacher. At the end of this page some final considerations and suggestions are provided for teachers.


TECH-ENHANCED SCIENTIFIC INQUIRY

This site will provide links to useful tech-enabled resources in Science

ABOUT | SCIENCE 8 | SCIENCE 9 | SCIENCE 10 | BIOLOGY 12 | TECH TOOLS

Alternative Final Assessment

This final exam was inspired through one of my courses during the MEd program with my professor, Alec Couros. We had Alan Levine as our guest speaker and he introduced our class to Pechaflickr as an icebreaker. I found it both engaging and entertaining and decided to use the concept to create a final exam for Biology 12. This idea worked particularly well for Biology since the course is heavily reliant on images throughout.

The Final

The actual final exam is a slideshow compilation of images in PowerPoint format relevant to Biology 12 curriculum. Students arrive in groups of 5 and alternate turns while speaking. Each student is provided with the opportunity to speak about 5 images for 30 seconds per image. Students are prompted to speak about the following:

1. What is the image of?
2. What is the function of the structure?
3. How is the structure specialized for its function?

The final exam begins upon display of the first image and ends once all students have had the opportunity to speak 5 times.

Figure 16. The Alternative Final Assessment for Biology 12.

Preparation

For two weeks prior to the actual final, students are added to a Dropbox account created by the teacher with accompanying folders for each curricular organizer. The folders included for Biology 12 were the following:

- BIOLOGICAL MOLECULES
- CELL STRUCTURES
- CELL TRANSPORT
- CIRCULATORY SYSTEM
- DIGESTIVE SYSTEM
- DNA REPLICATION
- ENZYMES
- EXCRETORY SYSTEM
- NERVOUS SYSTEM
- PROTEIN SYNTHESIS
- REPRODUCTIVE SYSTEM
- RESPIRATORY SYSTEM

Students were given the task to add 2 images to the appropriate folder. The instructions to students are outlined below:

YOUR TASK IS TO OBTAIN IMAGES FROM THE WEB WHICH COVER TOPICS IN BIOLOGY 12. YOU WILL CREATE A SEPARATE WORD OR PDF DOCUMENT FOR EACH IMAGE THAT YOU CHOOSE. PROVIDE A SHORT DESCRIPTION WITH THE IMAGE TO EXPLAIN STRUCTURE AND FUNCTION USING APPROPRIATE AND RELEVANT VOCABULARY.

WHEN NAMING YOUR FILE (IN EACH FOLDER) START WITH YOUR BLOCK, LAST NAME, FIRST NAME

EXAMPLE:

A, SMITH, JOHN

Figure 17. The Alternative Final Assessment for Biology 12.

BE SURE TO INCLUDE IMAGES OF INDIVIDUAL STRUCTURES AS WELL AS THE ENTIRE SYSTEM. YOU MAY USE ARROWS TO POINT TO SPECIFIC STRUCTURES AS WELL.

EACH STUDENT IS RESPONSIBLE FOR ADDING A MINIMUM OF 2 PICTURES.

YOUR TEACHER WILL MONITOR ALL FOLDERS AND ADD/REMOVE IMAGES AND DESCRIPTIONS AS NEEDED.

The following handout was given to students in preparation, prior to the final exam:

FINAL OUTLINE

The document below was used for evaluation purposes:

INTERVIEW MARKING

Due to the nature of the final, interviews were marked during the exam period and students were provided with immediate feedback in most circumstances.

Considerations:

Please feel free to use the final exam idea and handouts as you see fit and alter them to your satisfaction. Due to the large number of students and thus images in the Dropbox account initially, it was reduced to 100 images to make it more manageable for students (at the discretion of the teacher).

A practice final was demonstrated the week prior to the final with volunteers in the class to ensure students were aware of what to expect. It would perhaps be advantageous to have more interview-like experiences in class for the students to increase their level of comfort.

Feedback after the final was generally quite positive. Although students were nervous coming in, they felt confident that they had done well and knew what to expect. It was suggested to have 6 images for students and only count the best 5 out of 6 for the mark.

Due to the nature of the final, not every student will be evaluated on all curricular content. Teachers may wish to modify the number of images each student speaks to in order to address this issue.

If you have any questions or concerns, please feel free to respond in the comments section or email me at: hnagra@deltasd.bc.ca

Figure 18. The Alternative Final Assessment for Biology 12.

Future Vision for the Website

The new British Columbia K-9 Curriculum is due for implementation in the 2016-2017 school year, with grade 10-12 curriculum following in 2017-2018. It is anticipated that the website will undergo frequent revisions to ensure that the information is relevant and up to date including future curricular organizers. The current draft curriculum indicates broader, less specific learning outcomes with room for interpretation by teachers which aligns well with the inquiry-based learning approach presented in this website. Much of the topics in the previous curriculum have been conserved within the new curriculum, and have only shifted at the grades which they are found. Therefore, much of the current content and links on the website will still be relevant to teachers, at perhaps a different grade level.

The website has been created to generate dialogue among science teachers in the Delta School District to help support the development of the website through the sharing of thoughts, ideas and resources among teachers. Other teachers are invited to participate in enhancing this resource by sharing their ideas, activities and simulations. Conversation will be monitored through the comments feature of the website. The initial website will have scaffolding in place to allow for the addition of new resources recommended by other teachers. As other classroom teachers provide feedback, their user experiences will be shared, lesson adaptations and modifications will be suggested to increase the effectiveness of resources.

Currently the website is only accessible to teachers within the Delta School District with a DeltaLearns account. Once the website has grown and matured, it is intended that the resource will be shared globally. It is hoped that this resource will be accessed by as many interested teachers as possible who will help contribute to the website and increase the functionality for all users.

Chapter Four: Reflection

For my final Master's project I have created a website accessible to teachers in the Delta School District. The website is a curation of a variety of technological tools to promote inquiry-based learning in science. The resource includes simulations, digital videos, and user guides for teachers interested in implementing social media and mobile technologies. The courses currently included in the website are: Science 8, Science 9, Science 10, and Biology 12. There is room for additional courses to be added as the website matures and develops. This tool is currently in its growth phase, I plan on adding additional resources as they become available based on feedback from teachers in the district.

The website has been designed to be simple for teachers to access and adopt resources. Each course is divided into the unit organizers and links are provided to pages for each. Teacher ease-of-use was a guiding principle in the design phase of the website to increase efficiency for teachers. If resources are complicated to locate, teachers are less likely to use the website since they are often limited on time. To increase the functionality, each resource has also been indexed under the Tech Tools tab to locate a particular tool when the exact unit organizer is not known.

The goal of this website is to share resources I have found useful in my own teaching practice with other science educators. The hope is that others who access the website find the resources helpful and share other technology resources from their own toolkits. I would like to see this website flourish through collaboration among teachers in the district. Teachers are passionate about learning and increasing student engagement. The strategies they develop over the course of their careers are tremendous. All too often their expertise remains limited within the walls of their own individual classroom. I hope that through this website an online community of educators is created who grow professionally and thrive together.

The new British Columbia K-9 curriculum is due for implementation in the 2016-2017 school year with the grades 10-12 curriculum following the next year. Upon its arrival, the website will undergo frequent revisions to remain current and relevant for teachers. As the website has matured and developed, it will be shared globally for all those interested in accessing it.

Growth

Professional growth. This Master's program has challenged my teaching practice and forced me to reevaluate my beliefs as an educator. From the beginning of my teaching career, I have valued the importance of being current with advancements concerning teaching strategies and technology available to educators. During practicum, my advisors were impressed with my use of PowerPoint and providing students the opportunity to create projects and demonstrate their learning with technology. Since I began teaching, the pervasiveness of mobile technologies in the classroom has increased dramatically. These technologies have now become essential components of our daily lives which we rely on. As such, I have made a conscious effort to capitalize on the affordances offered by technology for learning. This has been further supported by the district offering Wi-Fi services to students in schools at all times.

At the beginning of my teaching career, I thought that using PowerPoint presentations instead of the traditional overhead projector was a huge technological leap that resulted in an increase in learning for students. What I have come to realize is that learning can be just as effective with or without technology. The technology is merely a tool designed to help supplement and support learning which can often be appealing initially. Teachers need to be wary of this appeal as it is short-lived and unless the tool is integrated in such a way that learning is enhanced by it, traditional non-technological methods may be just as, if not more effective.

Before beginning this program, I did not have a Twitter account, nor had I ever blogged. I have discovered how powerful both of these tools can be in terms of my own professional growth and learning. Twitter allows individuals to connect without the constraints of time nor location. These newly forged connections allow access to experts in a particular field who are readily willing to share their experiences and offer advice. These learning communities provide opportunity for feedback, collaboration, and insight into new ideas and resources. Perhaps one of the key affordances of Twitter is the immediacy of the feedback and the ability to connect with complete strangers through the use of hashtags. I plan on incorporating more use of Twitter for my own professional growth and as a means to remain connected with the TIEGrad cohort.

The initial thought of creating and maintaining a blog as part of this program seemed laborious to me. As the program progressed, my opinion changed drastically. Once I overcame the obstacle of learning how to use WordPress, I enjoyed blogging immensely. Blogging provided me with a platform to share and reflect on my learning. It forced me to consider my beliefs and how they have shaped me as an educator. Most significantly, it put me back into the role of a learner allowing me to reflect on the experiences of my students.

The aspect of blogging which I enjoyed most was the interaction with my peers in the program. I looked forward to reading their thoughts and experiences. Even though most of us have never met in person, I was able to develop a sense of their personal beliefs and life experience through this sharing. It also developed and strengthened our connections as a community. Being able to share our learning whether it be triumphs or struggles was especially beneficial over the course of the program. Our self-initiated coffee-chats on BlueJeans offered support by knowing we were facing the same challenges in juggling work, family and course work. We were able to support and encourage one another through the power of our online learning community. The experiences of this program would not have been the same if not for the connections forged among the TIEGrad cohort. I am grateful for having the opportunity to learn and grow with this amazing group of like-minded individuals. This interaction has reinforced how powerful a tool technology can be in forging connections to build a learning community.

Personal growth. I began this program with apprehension. I was immediately intimidated with the knowledge of my peers who seemed to understand the foreign language in our first month of BlueJeans sessions. The acronyms and names of individuals being used during our classes were completely unfamiliar to me. This intimidation steadily increased over the first few months of classes. As I progressed however, I realized that every individual had his or her own area of expertise. Our starting points varied and we were not all travelling the same path, however, collectively our group contained individuals who were experts in their own respective fields. I, as a high school math and science educator working with teenage youth, was able to provide insight from that perspective.

This program has reinforced many of my personal beliefs about education. This is especially true concerning assessment which has become a buzzword in the education community. My beliefs about assessment were particularly influenced through a workshop series I attended led by Damian Cooper. This program reinforced Assessment for Learning strategies and enforced the need for purposeful and meaningful assessment. I realized that although much of my own educational assessment was completed through traditional exams, there are many other effective methods for assessment. Effective assessment is varied and diverse providing learners the opportunity to showcase their learning. My classroom is a reflection of these beliefs, I continually provide different assessment strategies in order to accommodate the diversity of learners in my classroom. As a result, learners are able to flourish by taking advantage of their strengths.

As a result of this program, I was introduced to Alan Levine and his Pechaflickr website. This inspired the innovative final exam I designed and implemented for my Biology 12 classes. The exam was initially met with some resistance from students, but after their experience many commented that they preferred it over traditional written exam methods. Students also encouraged some of their other teachers to run a similar style final. It provided students with an alternative format to exhibit their learning that was just as effective as a traditional written exam if not perhaps more effective.

Final Thoughts

I believe that learning is a continual, life-long process. This graduate program has provided me with the framework to support other teachers interested in technology and inquiry. By no means do I consider myself an expert on the subject, however, I do feel that this program has equipped me with the tools necessary to support others on their journey. The shift to IBL for teachers may be challenging as it requires providing learners more control, however teachers need to begin with small changes and not feel the pressure to abandon the teaching strategies they have acquired. There is a learning curve in implementing IBL which will require time for learners to adapt to as well.

Within my school I have become a resource for teachers interested in developing their own personal website on WordPress. The district provides all teachers with access to DeltaLearns which is a self-hosted WordPress site accessible to all teachers and students within the Delta School District. I have previously ran professional development workshops for interested teachers to develop their own website. I have also added my students to the site to engage in blogging and facilitate interaction online. For the district professional development day in February 2016, I will be running a workshop to showcase my Tech-enhanced Scientific Inquiry website and provide guidance for those interested in implementing technology more effectively in their classroom.

Within my school and district this graduate degree will provide me with the potential to mentor other teachers with similar interests or those with minimal experience with technology. Recently, a variety of positions have been created at the district level to provide support for teachers. With the knowledge I have acquired through this program, I would be able to support those interested in inquiry and technology and help develop their own personal teacher's toolkit.

Recommendations

For individuals who are interested in using technology to promote inquiry in learning, I have a few recommendations. My first recommendation would be to do your research. There are a variety of resources available and more being designed constantly. Become familiar with the types of resources available and explore them for yourself. I have limited the types of resources used on my website, by no means do I consider it a comprehensive list. I am certain there are other resources that are available which would be equally if not more effective at promoting inquiry. It is best to become familiar with what is available and have some experience with it before you decide what is best for use in each circumstance.

My second recommendation ties in with the first. There are a variety of resources available which are cross-curricular. Websites which allow students to answer short online surveys or quizzes as a formative assessment tool can be powerful for teachers to gauge the comprehension of students for a particular topic. Cross-curricular tools were not added to my website (although there is potential for that in the future), however, they are still powerful tools. They may perhaps even be more significant since students and teachers can use them in a variety of courses rather than one particular subject area. These tools should be further explored for their potential in inquiry.

The third and final recommendation I have for teachers is to not abandon alternative learning strategies in the classroom in favor of technology. There is value in all that we do in the classroom whether it be projects, hands-on experiments, worksheets, and tests. Incorporate diverse strategies to meet the needs of multiple learners and provide opportunities for students to flourish. Do not feel the need to incorporate technology into each and every lesson.

I am grateful for the opportunity to have been a part of this Masters program. This learning experience has caused me to reflect on the daily lives of my students and reconsider the workload I assign them. I feel privileged to have had the opportunity to have grown with my amazing professors and the entire TIEGrad cohort. I wish the entire cohort luck in all their future endeavors and look forward to crossing paths.

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