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The Impact of Technology Innovations in High School Biology Courses on Science Learning for Hmong Students

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This is to certify that the doctoral dissertation by

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Abstract

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MA, Alverno College, Milwaukee, Wisconsin, 2015

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Dissertation Submitted in Partial Fulfillment

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Abstract

Hmong high school students struggle in science courses and have difficulty using technology, leaving them behind other ethnic groups in science performance. There is lack of research regarding Hmong students' struggle in technology-focused science courses, especially regarding the experiences of Hmong students with using science technology and teachers' experiences with these students. This single case study was designed to explore how technology innovations in high school biology courses impact science learning for Hmong students based on Gu, Zhu, and Guo's technology acceptance model. Both Hmong student and science teacher interviews as well as reflective journal data were collected to better understand students' opinions regarding usefulness and ease-of-use of technology in high school biology courses. Course document data were collected to determine technology integrations in lessons. Participants selected from a public high school in the Midwestern region of the United States included 8 Hmong students and 2 teachers. Data were analyzed within unit analysis and line-by-line coding to construct codes, then through cross unit analysis to develop themes. Results indicate that technologies have a positive impact on Hmong student science learning and aligned to the technology acceptance model. Key findings included positive use of technology, usefulness of technology and ease of use, and evidence of technology integration. The results can be used by teachers to improve support to minority students who learn biology using educational and scientific technology. The use of technology contributes to positive social change to advance Hmong students' acceptance of technology and biology learning, as well as the advancement of education to support all learners.

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Dedication

To my mother, Neng Thao Xiong, who started this journey with me, who was the driving force for me to pursue a career in education and was the intrinsic and extrinsic motivation in all of my years in school. I made it Mom, although it was your dream to see me finish, I am sorry and I am saddened that you did not have the opportunity to see me finish and share in my challenges and successes along the way. I only hope that I made you proud and you are smiling from above. To my father, Khoua Xiong, for without you I would have steered off tracked but you taught me to follow my dreams and that nothing is more than an educated son but a good son. To my wife, Poyee, and to my two children, Jailia and Jalen, for all the sacrifices you made, lost weekends with me in my room, and for enduring the many challenges that this experience has brought. Without all of you, I would have never made it to this day. There's always light at the end of the tunnel and I am honored to have all of you as my guides during this journey.

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Chapter 1: Introduction to the Study

The world today is interconnected with technical problems that requires students in K-12 instructional programs to think creatively, critically, collaboratively, and systemically and to communicate effectively using technology (Kim, Choi, & Wang, 2014; Shute, Oktay, & Kim, 2010). Due to the increase of technology use in K-12 schools, teachers have also increased technology use within the classroom to enhance the instructional and learning experiences of students (Odcházelová, 2015; Tsai, 2015). Research has shown that the interaction between learning technology and participants influences learning processes and outcomes (Gao & Wu, 2015). Science is a field of study that is rich in concepts, terminologies, and technological innovations to explore phenomena. The use of technology and multimedia could represent support for biology education (Odcházelová, 2015); however, the use of technology in biology is underrepresented among ethnic groups (Hoard, 2015). Students from minority ethnic and racial groups are also underrepresented in science careers (Hoard, 2015; Iannarelli, 2014; McCall & Vang, 2012). What is not understood is how science instruction that integrates science technology potentially impacts these students' science achievement, attitudes toward science, and college and career plans (Boyer & Tracz, 2014; Kanter & Kaonstantopoulos, 2010). The Hmong is an ethnic minority group that is impacted by science and technology. For example, science is a discipline that Hmong students find challenging (Huffcutt, 2010; Vang, 2013; Xiong & Lam, 2013). Science teachers who encounter Hmong students in their classrooms today are expected to effectively teach science content to these students (Ricketts, 2011). However, teaching science to Hmong students may be challenging for both teachers and Hmong students. Hmong students may not understand science instruction, and teachers may not utilize appropriate instruction and assessments that are aligned to the learning needs of Hmong students.

This study is needed because a lack of research exists about why Hmong students struggle in technology-focused science courses. Specifically, this study fill gaps in the literature related to understanding the perceptions of Hmong students' learning experiences in science using technology as well as the perceptions teachers have about how Hmong students learn science. This study may provide educators with a deeper understanding about how to best teach these struggling students. Examining why Hmong students have struggled in science may provide solutions to some of the challenges that Hmong students face when learning science. In addition, this study of Hmong learners is important not only to the Hmong community but to the global community that also includes Hmong students. School district educators may not be able to meet Hmong students' learning needs without developing an understanding of their challenges in school due to factors such as language barriers, over-representation as English Learners in K-12 public schools, lack of parent involvement, poverty status, remedial tracking, and unfamiliar expectations and requirements (Huffcutt, 2010; Xiong & Lam, 2013). In order to support Hmong students in science education, educators need to be informed on the underachievement of Hmong students. This study is important because the struggles that Hmong students face in learning science impact education as a whole. This study may help educators encourage Hmong students to learn, process information, and understand scientific concepts and science process skills so that they are able to function as global citizens in the world.

This study contributes to positive social change by improving the quality of education and the quality of living for Hmong students. In improving the quality of science education for Hmong students, opportunities exist for improving the academic performance of Hmong students, which may raise their scores on standardized assessments and promote their careers in science. Hmong students may also be encouraged to go to college to obtain a stable career and maintain financial stability. The goal is to provide Hmong students with supports to be successful in science and technology so they can be successful in society. By understanding the impact that science instruction and technology innovations have on Hmong students' science learning, educators can effectively develop resources to support these students. Therefore, in this study, I explored how technology innovations in high school biology courses impact science learning for Hmong students based on a technology acceptance model (TAM).

This chapter is an introduction to the study of Hmong learners and technology innovation in high school biology courses. The background information includes a summary of the research literature related to this study, gaps in the research literature, and the need for the study. This chapter also includes the problem statement, purpose of the study, research questions, conceptual framework, and nature of the study. In addition, this chapter includes an explanation of the definitions, assumptions, scope and delimitations, limitations, and significance of the study.

Background

Research has been found in relation to students' use of science technology, students' perceptions of the learning material, and the impact of technology on student learning for minority student (Ercan, 2014; Johnson & Galy, 2013; Oliveira, Camacho, & Gisbert, 2014; Osman & Vebrianto, 2013). Previous studies on technology integration, technology use by teachers and students, and acceptance of technology by students and teachers in the classroom has led to differences in teacher and student perceptions and attitudes about technology and the importance of technology (Gu, Zhu, & Guo, 2013; Johnson & Galy, 2013; Oliveira et al., 2014; Rafool, Sullivan, & Al-Bataineh, 2012). In addition, some researchers have examined the impact of education on Hmong students in terms of home environment, culture, and technology use and the importance of understanding Hmong cultural values, using authentic sources for teaching Hmong culture, and providing equal educational opportunities for Hmong students (Carpenter-Aeby, Aeby, Daniels, & Xiong, 2014a; Carpenter-Aeby et al., 2014b; Cobb, 2010; Dung, Deenanath, & Xiong, 2010; Her, 2014; Iannarelli, 2014; Lee & Green, 2010; Lor, 2013; Mahowald & Loughnane, 2016; Mao & Xiong, 2012; McCall & Vang, 2012; Supple, McCoy, & Wang, 2010; Upadhyay, 2009; Xiong & Lee, 2011; Xiong & Obiakor, 2013). With a focus on Hmong learners, other researchers have explored the integration of culture in relation to technology acceptance to determine the influence of cultural values on users, achievement, and self-esteem (Boyer & Tracz, 2014, Huster, 2012; Luong & Nieke, 2013; Nistor, Lerche, Weinberger, Ceobanu, & Heymann, 2014; Upadhyay, 2009).

Despite this research, two significant gaps still exist. One gap is that no research was found about how Hmong students perceive the use of technology in science courses. Little is also known about Hmong students' experiences with science technology. In addition, little is known about science teachers' experiences with Hmong students using science technology. Another gap is related to limited research on Hmong students' learning of science and science achievement. Research regarding Hmong educational experiences emerged in the 1980s but is still limited today (Iannarelli, 2014). Some research was found that is focused on the reading achievement of Hmong students but not their science achievement (Mahowald & Loughnane, 2016). Other studies were focused on Latino and Black students' educational achievement gaps, but the achievement gap among Asian students is largely understudied (Iannarelli, 2014). With few studies on Asian populations, current research is lacking about the educational achievement of Hmong students. Although some research has been found on the educational performance of Hmong students, it has not specifically been related to science. Furthermore, research on Hmong Americans has been documented at the elementary, middle, and college levels but not at the high school level. This study fills a gap in the literature by focusing on Hmong high school students in relation to their science and technology learning.

This study is needed because teachers may not understand Hmong sociocultural beliefs, values, and priorities, and may not know how to redesign or differentiate instruction to meet the learning needs of Hmong students (McCall & Vang, 2012; Ricketts, 2011; Upadhyay, 2009; Xiong & Lee, 2011). The low grade-point averages of

Hmong students may often be explained by their cultural and educational backgrounds as well as commonplace use of science in their everyday lives (Boyer & Tracz, 2014; Ripat & Woodgate, 2011). For example, the use of technology and the learning of scientific concepts are often new to the Hmong community, who may require guidance on technology usage and understanding of scientific concepts. Therefore, this study is needed because school and educators need to be mindful in understanding that Hmong students' distinct cultural context, ecological realities, and ethno-cultural dynamics serve as barriers to their learning (Boyer & Tracz, 2014). By understanding Hmong students' cultural beliefs and use of technology innovations, teachers can redesign more appropriate instruction for Hmong students in high school biology courses. Thus, this study provides a deeper understanding of how Hmong students learn with technology, how they perceive technology, how teachers perceive Hmong students' technology use, and how technology innovations are integrated into science courses.

Problem Statement

Hmong students have experienced a constant struggle to perform well in science courses (Upadhyay, 2009, p. 223). This struggle is often due to the rigor of science courses (Upadhyay, 2009), a lack of appropriate curriculum resources (Huffcutt, 2010), cultural differences (Dkeidek, Mamlok-Naaman, & Hofstein, 2011), differences in values between the teacher and the student (Upadhyay, 2009), and a lack of clarity in relation to teacher expectations and requirements (Huffcutt, 2010; Lyon, Bunch, & Shaw, 2012). Culture has been shown to impact students' abilities to use higher level thinking skills in science, which often makes Hmong students feel disconnected to science and creates a cultural disconnection between the home and the school (Dkeidek et al., 2011). Concerning teacher perceptions about the engagement and achievement of Hmong students, teachers often perceive Hmong students as culturally inferior with less acumen, less intelligence, and less ability to do well in science (McCall & Vang, 2012; Upadhyay, 2009). As a community, the Hmong have experienced digital literacy challenges because the use of computer technology is new to most Hmong people because technology is not a part of their everyday cultural practices (Luong & Nieck, 2013). Few Hmong have computers in their homes, so Hmong students may have less exposure to technology than other students. These challenges may lead Hmong students to perform poorly with regard to technology. Johnson and Galy (2013) contended that minority students often lack essential technological capabilities, which may enhance their anxiety about using technology. Although no research exists on how Hmong students perceive the use of technology in science courses, Lewis, Agarwal, and Sambamurthy (2003) found a positive influence regarding culture and students' beliefs of technology usefulness (Gu et al., 2013). Despite significant research in educational technology, little is known about students' experiences with technology (Beckman, Bennett, & Lockyer, 2014). More importantly, little is known about Hmong students' experience with technology in science courses. Therefore, the problem related to this study is the lack of research about why Hmong students struggle in technology-focused science courses.

Current research indicates that the lack of research about why Hmong students struggle in technology-focused science courses is a problem that is both relevant and meaningful to the field of educational technology and science education. One reason the problem is relevant and meaningful is that it impacts how Hmong students and their science teachers interact and how teachers implement technology in their courses. Teachers report that they are unprepared to teach technology-based science to Hmong students (McCall & Vang, 2012). Hmong students often feel disconnected from school because their science courses fail to connect with their lived experiences, which impacts their interactions with the teacher and other students (Upadhyay, 2009). Another reason this problem is relevant and meaningful is because the success of Hmong students in these courses may determine whether they decide to pursue science and technology-related careers. Hmong students still lag behind other ethnic groups in science performance, and the attainment of science degrees remains lower than in other content areas for Hmong students (Xiong, 2010; Xiong & Lam, 2013). According to the National Opinion Research Center (2010), the percentage of Hmong who have received doctorate degrees in science (0.001%) is relatively low in comparison to Non-Hispanic White (37.1%), Hispanic (30.1%), Black/African American (22.7%), and Asian of Japanese, Chinese, and Korean descendants (47.1%). Of the 502 Hmong doctorates in the United States today, only 262 are doctorates in science (Hmong Christian Fellowship, 2014). Thus, the goal of this study was to develop a deeper understanding of how technology innovations can become powerful catalysts for instructional change in science classrooms and as tools for redesigning more appropriate instruction for Hmong students in high school biology courses.

Purpose of the Study

The purpose of this qualitative study was to describe how technology innovations in high school biology courses impact science learning for Hmong students based on a TAM. To accomplish this purpose, I used a TAM that Gu et al. (2013) developed that included the constructs of outcome expectancy, task-technology fit (TTF), social influence, and personal factors to understand this impact. With this model, I describe how Hmong students perceive the usefulness and ease-of-use of technology innovations in high school biology courses as well as how high school biology teachers perceive the usefulness and ease-of-use of technology innovations for Hmong students in their classrooms. In addition, I analyzed course documents to determine how technology innovations are integrated into high school biology courses.

Research Questions

The research questions for this study were related to the conceptual framework and the literature review for this study. The research questions included one central question and three related research questions. The four research questions allowed me to investigate both the perceptions of Hmong students and biology teachers to understand Hmong students' use of technology.

Central Research Question

How do technology innovations in high school biology courses impact science learning for Hmong students based on a technology acceptance model?

Related Research Questions

1. How do Hmong students perceive the usefulness and ease-of-use of technology innovations in high school biology courses?
2. How do high school biology teachers perceive the usefulness and ease-of-use of technology innovations for Hmong students in their courses?
3. What do course documents reveal about how technology innovations are integrated into high school biology courses?

Conceptual Framework

The conceptual framework for this study was based on a TAM, which is a theory about information systems to explain user acceptance and use of technology. Davis (1985) developed the TAM, which consisted of two constructs to explain a technology user's motivation—perceived ease of use and perceived usefulness. According to Davis, the perceived usefulness and perceived ease of use determines the behavioral intention to use a target system. Davis derived his model from Fishbein and Ajzen's (1975) theory of reasoned action, which was focused on students' attitudes toward using the system. According to Fishbein and Ajzen, engagement in specific behavior is subject to the influence from the intention to execute such behavior, and behavioral intention is subject to the influence from the individual's attitude. Venkatesh and Davis (2000) extended Davis' model by adding a new construct known as the *subjective norm* to depict social influences.

Gu et al. (2013) updated the TAM model to include four constructs, which is the basis for the conceptual framework for this study. Based on current findings in technology acceptance literature, these four constructs include outcome expectancy, TTF, social influence, and personal factors. Gu et al. combined the first two constructs of the original TAM into one construct called *outcome expectancy*, which is noted in the literature as best predictor of technology acceptance (Venkatesh, Morris, Davis, & Davis, 2003). Outcome expectancy, Gu et al. noted, is how an individual perceives the technology should be used (2013, p. 400). The second construct is task-fit or *task-technology fit* (TTF), which is also referred to in the literature as effort expectancy. The TTF is focused on how well the technology choice fits the need of the individual's goals (Gu et al., 2013, p. 400). Both of these first two constructs fall under the larger category of beliefs about technology. The second two constructs of Gu et al.'s TAM are social influence and personal factors. Both of these constructs are additions to Davis's (1985) TAM. The construct of *social influence* was developed to recognize that individuals consider family and peers in the decisions they make. Gu et al. added this construct to consider research that social pressure, either positive or negative, can alter the beliefs of technology acceptance and use (Nistor et al., 2014). The last construct is *personal factors*, which includes computer self-efficacy and personal innovativeness with technology, both of which have shown to have positive correlations with successful technology integration (Gu et al., 2013). These last two constructs that Gu et al. added, social influence and personal factors, are the reasons why this model was chosen over the original TAM. Because this study is about the impact of technology innovations on a specific cultural group of students in science courses, the original TAM would not be sufficient to expand social influence and personal factors because the original TAM was only focused on perceived ease of use and perceived usefulness. Thus, the theoretical proposition for this study was that outcome expectancy, TTF, social influence, and personal factors should be examined to determine why students accept and use technology.

Nature of the Study

For this qualitative study, I used a single case study design with two units of analysis. Yin (2014) defined case study in two parts. In the first part, Yin defined case study as an empirical inquiry that "investigates a contemporary phenomenon in depth and within its real-world context" even if the "phenomenon and context may not be clearly evident" (p. 16). In the second part, Yin added three methodological characteristics of a case study as "including more variables of interest than data points," "relying on multiple sources of evidence," and benefiting from "prior development of theoretical propositions to guide data collection and analysis" (p. 17). The unit of analysis for this study is a technology innovative biology course with one or more sections offered at a high school located in a public school district in the Midwestern region of the United States. One case was presented with two units of analysis. Participants included selected students enrolled in the innovative biology courses and teachers who are certified to teach the courses. The participants at the high school included four students per course for a total of eight students and two teachers. Overall, participants included eight students and two science teachers. Further details about participant selection is described in Chapter 3.

Data were collected from multiple sources, including individual student interviews, individual teacher interviews, online reflective journals maintained by both teacher and student participants, and documents related to the integration of technology in these courses. Data were analyzed at two levels. At the first level, a single case analysis consisted of coding and categorizing the data for each source for each case. The coding process involved the use of Microsoft Word to create a code document as recommended by Hahn (2008) for level one coding or initial coding, and the use of line-by-line coding that Charmaz (2006) recommended for qualitative research. Categories were constructed from the coded data using the constant comparative method that Merriam (2009) recommended for qualitative research. At the second level, which is the cross analysis of embedded units, Microsoft Excel was used to create a coding table to consolidate all of the codes and all of the data that are related to the codes into a single workbook as recommended by Hahn. The data were then examined for emerging themes and discrepant data, which formed the key findings for this study. These findings were analyzed in relation to the central and related research questions and interpreted in relation to the literature review and the conceptual framework for this study.

Definitions

The following research-based definitions are presented as significant to understanding this study. Definitions specific to technology and biology are provided. Because this study is focused on Hmong students, the term *Hmong* is also defined.

Biology technology: Technology used in the biological sciences to collect, measure, and analyze scientific data, which may include biology-specific probes and devices such as fiber optic systems, optic signal generator, EKG sensors, EKG Electrodes, hand-grip heart rate monitor, blood pressure sensor, temperature probe, surface temperature sensor, accelerometer, hand dynamometer, spirometer, and gas pressure; bio-mathematical models such as neurobehavioral performance or DNA synthesis, software such as LoggerPro, LabQuest, LabView, and Inspiration; and instruments and equipment such micro-pipettors, fetal Doppler, incubators, microscopes, electronic scales, micro-centrifuges, PCR amplifiers, and vortexes. In addition, biology technology may include mobile device apps that aide in the collection, measurement, or analysis of biological data such as LoggerPro and Vernier Graphical Analysis. Biology technology is a subset of science technology (Abe, Mollicone, Basner, & Dinges, 2014; Çıldır, 2016; PLTW, 2016).

Educational technology: Student learning that is defined by creating, using, and managing appropriate technological processes and resources. The practices include computer learning environments that offers multiple representations to provide instant feedback or instant search of structured information based on student needs, interest, or goals. Educational technology may include online labs or virtual labs that provide computer simulations to allow for manipulation of virtual material and equipment on a computer screen. In addition, iPads, cell phone, Smartboards, and social media are educational technology that fosters students' learning and motivation (Januszewski, & Molenda, 2010; Preston et al., 2015, Zacharia et al., 2015).

Electronic learning: Electronically-supported learning and teaching can be either offline or online; instruction can be delivered in electronic media formats of satellite broadcast, audio/video tape, TV and CD-ROM, and Internet, intranet, and extranet interactive. Electronic learning, which is abbreviated as e-learning, does not necessarily require either a computer or an internet connection but only the use of electronics (Al-Azawei & Lundqvist, 2015; Jung, 2015; Ngafeeson & Sun, 2015).

Hmong: An Asian minority group with a long history of being displaced throughout several countries due to persecution, genocide, and power struggles (Carpenter-Aeby, Aeby, Daniels, & Xiong, 2014b).

Information technology: Computer software and hardware applications to collect, process, and disseminate information that positively affects the productivity of cooperation. Information technology includes any computer application and required hardware, computer-aided manufacturing, computer-aided design, electronic data interchange, and enterprise resource (Oon & Sorooshian, 2013).

Mobile learning: A subset of e-learning that includes handheld devices and portable electronics such as mobile phones, iPads, tablets, laptop computers or notebooks, MP3 and MP4 players, digital cameras, gaming consoles, and e-texbooks (Jung, 2015; Ngafeeson & Sun, 2015).

Multimedia learning: Learning that takes place when students record information presented by visually presented animation, verbally presented explanation through technology such as interactive whiteboards, tables, computers, and equipment for audio and video presentations; and interacting with the information in different ways (Nugraini, Choo, Hin, & Hoon, 2013; Odcházelová, 2015).

Outcome (Performance) expectancy: The first component of the technology acceptance model (TAM) that describes students' acceptance of technology is based on perceived usefulness or actual use of a technology. As indicated by Gu et al. (2013), the usefulness, ease of use, relative advantage, and performance of the technology contributes to the outcome.

Perceived ease of use: A subcomponent of outcome expectancy within the technology acceptance model (TAM) that is students' perceptions of how effortless or easy technology is to use (Gao & Wu, 2015; Ngafeeson & Sun, 2015).

Perceived usefulness: A subcomponent of outcome expectancy within the technology acceptance model (TAM) that most strongly predicts the use of technology (Gu et al., 2013, p. 392) and the perceived effectiveness of improving a student's performance or being useful to an individual (Gao & Wu, 2015; Ngafeeson & Sun, 2015).

Personal factors: The fourth component of the technology acceptance model (TAM) that describes a student's self-efficacy and personal innovativeness in technology usage (Gu et al., 2013, p. 392).

Project Lead the Way (PLTW): A nonprofit organization that works to bridge the college and career preparation divide and empower students with the knowledge and skills they need to thrive in a rapidly advancing, technology-based world. PLTW provides students with a hands-on, project-based curriculum (Cahill, 2016). Core training involves a hands-on and collaborative approach where teachers take on the role of students, engage in in-depth exploration of PLTW coursework, and share their experiences back in their classrooms. Through core training, teachers build skills and confidence related to problem-based learning in order to help them bring learning to life.

Science technology: Hands-on apparatus or learning tools designed specifically to carry out science investigations. Science technology includes the use of computers combined with probewares such as Vernier LabQuest and Pasco AirLink, and equipment such as micropipettes, thermal cyclers, centrifuge, vortex, trays, and gel boxes (Bigler & Hanegan, 2011).

Self-efficacy: The belief that an individual has the ability to perform a specific task (Adetimirin, 2015).

Social influence: The third component of the technology acceptance model (TAM) where an individual believes that other students have the ability to affect his or her use of the new system (Adetimirin, 2015). Social influences may include social pressure, relationships with others, and environmental stimuli.

Subjective norm: The social pressure of others to perform or not perform a given task. It is the user's perception that other people think they should or should not perform a particular behavior (Ngafeeson & Sun, 2015).

Task-technology fit (TTF): The second component of the technology acceptance model (TAM) where a technology assists a student in performing or completing his or her task (Gu et al., 2013).

Technology acceptance model (TAM): An explanatory model to provide a basis as to how external variables influence the students' beliefs, attitudes and intention toward using technology and the actual use of a technology. The TAM is made up of four components that include outcome expectancy, task-technology fit, social influence, and personal factors. The purpose of TAM is to identify the determinants involved in computer acceptance and explain user acceptance or rejection of information technology (Adetimirin, 2015; George & Ogunniyi, 2016).

Technology innovations: Students' use of educational technology and biology technology in the teaching of science related course content. Biology technology allows students to use biology-specific probes and devices, software, and instruments and equipment (Cildir, 2016; PLTW, 2016). Educational technology allows students to use computer, mobile devices, and web tools to learn about science (Preston et al., 2015).

Technology innovativeness: The process of adopting new technology (Ngafeeson & Sun, 2015).

Assumptions

This study is based on two assumptions. The first assumption is that the interview data is current and accurate. Obtaining accurate and current data is important in supporting the examination of both student and teacher perceptions about technology use. Obtaining accurate and current data is also important because empirical descriptions provide alternative ways of conceptualizing academic learning, development, social identification, and levels of explanation (Wortham, 2015, p. 135). In addition, interpretations about teaching and learning are frequently taken for granted, so collecting accurate and current data may promote an improved understanding about the interrelated factors that impact how technology influences student learning (Kirkwood & Price, 2013, p. 537). Thus, it is important to obtain relevant data to understand how technology and teachers come together to facilitate the learning of science for Hmong students.

The second assumption is that both teachers and students were open and honest in reporting their views of educational technology and biology technology use. This assumption is important because teachers and students should not hold back any beliefs that may influence the outcome of this study. The beliefs of both students and teachers, which should be based on their existing abilities, skills, confidence, comfort levels, and experiences, may have elicited the highest quality data for this study (Teachman & Gibson, 2013). Building on this assumption is the notion that written examinations may have allowed for the reasonable and accurate measure of ability, which is an inherent and relatively immutable capacity (Wilkinson & Penney, 2014). The construction of written interview questions should have allowed for open and honest responses because students and teachers create identities that emerge, solidify, and change across time in classrooms (Wortham, 2015). An extrinsic interconnection also exists between social identification and academic learning in the classroom for students and teachers (Wortham, 2015). Similarly, an interconnection exists between student and teacher perceptions and science learning in the classroom. In addition, both teacher and student perceptions may influence the acceptance of educational technology and biology technology in high school science courses.

Scope and Delimitations

A case study is a bounded study, and the scope of a case study is related to its boundaries. For this study, the boundaries that narrowed this study are grade level, course, and location. The scope of this study included innovative biology courses for students in Grades 9-12 at an urban high school located in the Midwestern region of the

United States. This public school district is located in a racially and ethnically diverse city with a population of about 600,000 and included the largest Hmong population in the state. In addition, the high school involved in this study enrolls a significant number of Hmong students.

The scope of this study was further narrowed by participants, time, and resources. The participants narrowed this study because they included purposefully selected high school biology teachers and Hmong students who are enrolled in the courses at the research site. In terms of time, data were collected over a period of 1 to 2 months during July and August of 2017. In addition, resources also narrowed this study because I am a single researcher with limited time.

Limitations

The limitations of this study are related to the qualitative research design of case study. The first limitation is related to the transferability of case study results. Although collecting and analyzing data from multiple sources of evidence will strengthen the construct validity of a case study (Yin, 2014), the results of this study may only be transferable to similar populations of Hmong students and teachers found in similar high schools located in other regions of the United States. Likewise, the results of this study may only be transferable to high school biology teachers and students who are involved in other PLTW programs. However, this limitation was addressed by providing sufficient description of the data collection and analysis processes as well as the research setting, participants, and findings. Another limitation is researcher bias because my role as the principal researcher accounts for full responsibility over data collection and analysis.

However, I used specific strategies to address this potential bias, including triangulation, member checks, and reflexivity. These strategies are presented in Chapter 3 in the section about issues of trustworthiness in relation to qualitative research. Another limitation is the use of a single conceptual framework, the TAM (Adetimirin, 2015; Gu et al., 2013). The limitations of TAM include the failure to take into social consideration of the use of information technology and system regarding social development, technology enhancement, and social consequences (Adetimirin, 2015). However, Gu et al.'s (2013) version of the TAM was chosen because it includes a social influence component that may address this limitation.

Significance

The significance of the study is determined in relation to advancing knowledge in the field, to improving practice in the field, and to contributing to positive social change. In relation to advancing knowledge, researchers and educators may develop a deeper understanding of how innovative technology-based science programs and their related courses impact technology use for minority students. In relation to improving practice, this study may encourage science teachers to improve their instruction by using technology to provide personal, hands-on, and relevant learning. In addition, students may receive additional support from their science teachers about how to effectively use technology in science classrooms. District and school administrators may also provide more effective teacher training in how to improve technology use in science classrooms. In relation to positive social change, this study has the potential to improve academic experiences in science for Hmong students, and possibly other minority students, in regard to technology use in science classrooms. Hmong students may better understand how to apply technology to solve complex scientific problems. As a result, Hmong students may become more effective problem solvers who can lead their own learning by identifying problems, finding solutions, and testing solutions using innovative thinking and technology.

Summary

Chapter 1 was an introduction to the study. This chapter included the background knowledge and problem statement that describes a need for this study. The purpose of this study was to describe how technology innovations in a high school biology course impact science learning for Hmong students based on a TAM. The central research question and related research questions are related to the conceptual framework of TAM and are based on the four constructs of Gu et al. (2013), which includes outcome expectancy, TTF, social influence, and personal factors. In addition, Chapter 1 focused on the nature of the study, which included the selection of a case study design that has a specific scope and delimitations and limitations. Also included in this chapter was a discussion of the significance of the study, which is connected to advancing knowledge in the field, to improving practice in the field, and to contributing to positive social change.

Chapter 2 includes a review of the literature in relation to Hmong learners, technology acceptance, students' perceptions of technology use, and teachers' perceptions of technology use. Chapter 3 includes the research method used to conduct this study.

Chapter 2: Literature Review

A significant problem related to this study is the lack of research about why Hmong students struggle in technology-focused science courses. Although research has been conducted on students' use of science technology (Barko & Sadler, 2013; Gu et al., 2013; Kim, 2018; Neufeld & Delcore, 2018; Yang, Wang, & Chiu, 2015), students' perceptions of the learning material, and the impact of technology on student learning for minority students (Alkholy, Gendron, McKenna, Dahms, & Ferreira, 2017; Huffcutt, 2010; Johnson & Galy, 2013; Jordt, Eddy, & Brazil, 2017; Lin & Lin, 2016; McKim et al., 2018; Stipanovic & Woo, 2017), little is known about the impact of technology innovations in high school biology for Hmong students (Beckman et al., 2014; Dkeidek et al., 2011; Lewis, Agarwal, & Sambamurthy, 2003; Lyon et al., 2012; McCall & Vang, 2012; Ripat & Woodgate, 2011; Upadhyay, 2009). Although significant research exists about educational technology, little is known about Hmong students' experience with technology (Iannarelli, 2014; Mahowald & Loughnane, 2016). No research was found in this review on how Hmong students perceive the use of technology, but some researchers have found that Hmong students struggle to excel in technology rich science courses (Upadhyay, 2009). A lack of research was also found in regard to why Hmong students' struggle in technology-focused science courses. Therefore, the purpose of this case study was to describe how technology innovations in high school biology courses impact science learning for Hmong students based on a TAM.

A review of the current research literature for this study established the relevance of the research problem. The cultural and linguistic differences of Hmong students pose a problem in terms of learning science and technology (Brown, 2017; Carpenter-Aeby, Aeby, Daniels, & Xiong, 2014a; Mahowald & Loughnane, 2016; Romstad & Xiong, 2017; Yang, 2012). High school students accept the use of technology for learning, but their acceptance of technology depends on outcome expectancy, TTF, social influence, and personal factors (Cacciamani et al., 2018; Puhek, Perše, Perše, & Šorgo, 2013; Yusoff, Zaman, & Ahmad, 2011). Limited research has been found regarding technology acceptance in high school biology that may impact high school science education (McMullin & Reeve, 2014). Pertaining to high school students' perceptions of technology use, the literature review showed that attitudinal, cognitive, and motivational elements contributed to student perceptions (Fonseca, Costa, Lencastre, & Tavares, 2012; Giannakos, 2014; Hagay & Baram-Tsabari, 2012, Hsu & Hwang, 2017). Some student perception studies yielded positive outcomes in terms of learning and engagement, attitudes, and interests, whereas other studies yielded negative outcomes (Çakır and İskar, 2015; Lin & Lin, 2016; Yang et al., 2015). In terms of teachers' perceptions of technology use, teachers' perceptions of technology use and biology technology use varies. The literature review suggested that teachers' perceptions of technology and biology technology use are shaped by perceived usefulness and perceived ease of use, and effectiveness of the technology (Adukaite, Van Zyl, & Cantoni, 2017; George & Ogunniyi, 2016; Khlaif, 2018; Mac Callum, Jeffrey, & Kinshuk, 2014; Puhek et al., 2013). Although there is some research on technology use, limited research was found on teachers' views of technology use in biology courses. Overall, a need still exits to understand Hmong learners, technology acceptance, biology technology acceptance, and students' and teachers' perceptions regarding technology use and biology technology use.

This chapter is a review of the literature that includes an analysis of research about technology use and acceptance and the conceptual framework that is the basis of this study. The review of current literature is presented in relation to the case or phenomenon for this study and establishes the relevance of the research problem. The first section of the literature review focuses on research related to Hmong learners and science, Hmong learners and technology use and acceptance, social influences unique to Hmong learners, and personal factors unique to Hmong learners. The second section focuses on research about the definitions of technology acceptance and technology acceptance in high school biology courses. The third section includes an analysis of both qualitative and quantitative research about students' beliefs about technology use in science and students' beliefs about technology use in biology. Similarly, the fourth section includes an analysis of both qualitative and quantitative research about teachers' beliefs about technology use in science and teachers' beliefs about technology use in biology courses. In addition, this section ends with an analysis of research about teachers' beliefs about culture and its influence on learning. A summary and conclusion is also presented that includes a discussion of the themes and gaps found in the review.

Literature Search Strategy

Various search strategies were used to locate scholarly peer-reviewed journals within the last 5 years for this literature review. The databases selected for the literature search included Academic Search Complete, eBook Collection (EBSCOhost), Education

Research Complete, ERIC, and Research Starters–Education. The following subject terms were used when searching for articles to review: *Hmong, Asian, Asian American, minority, technology acceptance model, technology,* and *science*. The following key words were used to conduct this search: *students, student attitudes, teacher attitudes, perception, high school, technology use and acceptance, technology acceptance, educational technology, secondary science, study and teaching, social influence, social interaction, personal identity, task technology fit, Project Lead the Way, computer technology, biology,* and *STEM education.*

Conceptual Framework

The TAM is a framework that has been used to study technology's use in classrooms for decades. The purpose of the TAM that Davis (1985) originally developed was based on the view of acceptance as an attitude toward technology. The model provided a way to study the acceptance of students using technology and how that impacts learning in the classroom. It is a model that is associated with information and communication technology (ICT) research (Fleming, Motamedi, & May, 2007) and more recently with educational technology research in social media, and web 2.0 (Meseguer-Artola, Aibar, Lladós, Minguillón, & Lerga, 2015). Studies conducted in educational settings regarding attitudes toward technology resulted in several adaptations of Davis's version of the TAM (Nistor et al., 2014). For example, the unified theory of acceptance and use of technology (UTAUT) model that Venkatesh et al. (2003) developed as well as the addition of social aspects of technology acceptance that Gu et al. (2013) included are both based on Davis's TAM model.

The conceptual framework for this study is based on modifications of the TAM that Gu et al. (2013) developed. In this model, four predictors of technology use are included that are related to students' intentions and actual use of technology. Students' acceptance of technology in this model is predicted from internal beliefs and usage attitudes. The four predictors of technology acceptance include outcome expectancy, TTF, social influence, and personal factor. Each of these predictors explains the determinants of individual acceptance and use of technologies.

Outcome Expectancy

Gu et al. (2013) verified outcome expectancy as the most important predictor of technology use. Another name for outcome expectancy is performance expectancy. The term *outcome* is defined as the user's acceptance of technology based on perceived usefulness or actual use of a technology. Gu et al. contended that the usefulness, ease of use, relative advantage, and performance of the technology contributes to the outcome. For example, the outcome of using technology may be useful or positive for people if the technology is simple to operate, helps them accomplish a task effectively, and improves performance. On the other hand, the outcome expectancy may be negative for people if the technology is difficult to operate, takes longer to accomplish a task, and decreases performance. Thus, a positive experience is perceived as useful and generates good beliefs and attitudes toward the use of technology. Conversely, a negative experience generates bad beliefs and attitudes toward the use of technology.

Researchers have also provided evidence about the importance of outcome expectancy related to technology acceptance. The acceptance of technology is based on the outcome of the intention to use or "how likely it is the [student] intend to use the system" (Li, Duan, Fu, & Alford, 2012, p. 936). Performance expectancy is also a key determinant in influencing students' acceptance of technology use (El-Gayer, Moran, and Hawkes, 2011; Nistor et al., 2014). The benefits of the use of technology include the intention to use and reuse, and student satisfaction (Li et al., 2012). Furthermore, the factor influencing the intention to use technology is based on students' perceived ease of use, where perceived ease of use has the strongest significant influence on perceived usefulness (Van De Bogart & Wichadee, 2015). Thus, perceived usefulness is a contributing factor of the intention to use technology. Technology outcome expectancies benefit the success of individuals, organizations, industries and nations (Li et al., 2012). Thus, outcome or performance expectancy is a significant and well-established component in the TAM.

Task-Technology Fit

The second component of the TAM is called TTF or effort expectancy. Gu et al. (2013) described TTF as the "degree to which a technology assists an individual in performing his or her tasks" (p. 394). The concept of TTF is important to the TAM because students are more likely to accept technology due to its potential benefits in accomplishing a task, regardless of their attitudes. TTF is often described as the use of technology to assist a student in task performance and completion. For example, when the technology meets the task requirements of students, it will yield a positive impact on their performance. Similar to outcome expectancy of perceived usefulness, the benefit of TTF is that it allows students to accept technology due to performance improvement and task completion. Additionally, as technology competency increases, so do students' perceptions of TTF (Gu et al., 2013)

The literature shows that TTF is critical when studying technology acceptance. TTF is intrinsically related to outcome expectancy where ease of use has a positive correlation with students' belief that technology will help attain gains in school performance (El-Gayer et al., 2011). In a study of 360 students' acceptance of Tablet PC based on students' attitudes and perceptions, TTF influenced students' acceptance of the Tablet PC (El-Gayer et al., 2011). In support of TTF, Shih and Chen (2013) stated that "technology positively impacts individual performance if it is well utilized, and technology adoption depends in part on how well the new technology fits with the task it supports" (p. 1011). TTF has a significant and direct effect on the behavioral intention to use technology (Shih & Chen, 2013). In addition, Kuo and Lee (2011) emphasized that a good fit between the functionality of the system and the task should increase student perceptions of technology usefulness. TTF is a well-established component of the TAM that describes how user-friendly technology is and how well it increases productivity to accomplish a task.

Social Influence

The third component of the Gu et al.'s (2013) TAM is social influence. Social influence is defined as the "perceived social pressure to perform or not to perform a behavior" (Gu et al., 2013, p. 394). Social influence has also been described as the "degree to which a student perceives that important others such as faculty, advisors, and peers believe he or she should use [technology]" (El-Gayer et al., 2011, p. 61). Whether the use of technology or an innovation is adopted or rejected, the decision is affected by the relationship with others. Social influence, the third construct of Gu et al.'s TAM, is important because the influence of the environment has been found to relate to the beliefs of the usefulness of technology (El-Gayer et al., 2011). This social influence considers the use of technology both in and out of school, accounting for influences of friends, culture, and family. Social influence may not account for the use of technology outside of school, but it accounts for the use of technology inside the classroom (Gu et al., 2013). Social influence is included in this version of the TAM because people learn from one another through communications with trusted friends.

Although not included in the original TAM framework, social influence has been shown in research to impact a student's intentions and attitudes related to technology use. El-Gayer et al. (2011) suggested that social influence has a significant and positive effect on technology acceptance; social influence continues to influence behavior, and students become vulnerable to social influence over time (p. 68). Furthermore, other researchers have found that social influence plays an important role in student adoption of multi-person applications and technologies (Qin, Kim, Hsu, & Tan, 2011). Social influence is a viable construct to predict the usage intention of technology (Neufeld & Delcore, 2018; Qin et.al. 2011). In addition, students' behavioral intention to use information technology may be affected by social influence (Chen, Lin, Yeh, & Lou, 2013). Thus, social influence has a direct correlation with behavioral intentions and self-efficacy regarding technology usage. Overall, these studies support the findings of Gu et al.

(2013) that social influence has a positive and significant impact on technology utilization.

Personal Factors

The last component of Gu et al.'s (2013) TAM is personal factors. Similar to social influence, Gu et al. introduced the construct of personal factors to better understand student's use of technology in and out of school. Personal factors are described as computer and technology self-efficacy and personal innovativeness (Gu et al., 2013). *Self-efficacy* is defined as the "belief in one's capability to perform a particular behavior" whereas *personal innovativeness* is defined as the "degree to which an individual is willing to try out any new information technology" (p. 394). Both self-efficacy and personal innovativeness are associated with positive technology use. Gu et al. found that personal factors are beneficial for students and teachers because their confidence, competence, and attitudes contributed to successful technology usage.

Other researchers have also considered personal factors important in relation to technology acceptance. Self-efficacy has been found to influence learner's engagement, performance, and satisfaction in e-learning (Li et al., 2012). The importance of self-efficacy is in building students' abilities to perform certain learning tasks. A student's learning style may allow the student to perform specific tasks even though the use of technology may or may not fit the student's learning style and even prevent the student from accomplishing the task. Learning styles should also be considered when considering technology acceptance. Therefore, researchers have also examined personal factors, such as *learning styles*, in relation to technology acceptance. Al-Azawei and

Lungvist (2015) studied learning styles as a potential influence on perceived usefulness and satisfaction of technology. Learning styles are significant because the learning styles of students need to match the teaching styles of teachers to impact "academic achievement, learning time, learning patterns, and learner satisfaction" (Al-Azawi & Lungvist, 2015, p. 411). Therefore, students' perceived usefulness and satisfaction of technology may rely on accommodating their learning styles. Al-Azawei and Lungvist (2015) indicated that perceived usefulness and satisfaction with technology is affected by the individual experience of learners and by the technology maturity of the user and/or the age of the technology. Although the personal factors of self-efficacy and learning style affect technology acceptance and satisfaction, other variables may significantly affect learner satisfaction as well. The variable of culture as a personal factor influences people's beliefs and behaviors toward computers (Rafolow, 2018; Sadeghi, Saribagloo, Aghdam, & Mahmoudi, 2014). The comparison of intracultural differences is also significant in influencing students' attitudes and beliefs about technology acceptance. Rafolow (2018) indicated that the digital skills of technology that students bring with them to school are valuable cultural capital for achievement. Thus, personal factors, including self-efficacy, learning styles, or cultural values, may influence students' technology acceptance in educational courses.

Hmong Learners

The Hmong are an Asian minority group who have lived, migrated, and been displaced throughout Southeast Asia for over 200 years (Carpenter-Aeby et al., 2014a; Mitchell-Brown, Nemeth, Cartmell, Newman, & Goto, 2017). The history of Hmong learners and their struggle for literacy and instructional acquisitions began in China, Laos, Vietnam, and Thailand before they began immigrating to the United States as refugees. Historically in China, the Hmong did not have a written language, and therefore, they are illiterate in the Chinese language and their own native language (Mahowald & Loughnane, 2016). In Laos, although French colonialism established schools in the 19th century, an agrarian lifestyle did not allow the majority of them to take advantage of speaking, reading, and writing in Laos. In addition, literature was not written in Hmong but in French and Laotian so Hmong students were not equipped with the language skills to access and utilize this literature (Yang, 2012). In the 1970s, many Hmong became refugees during the aftermath of the Vietnam War and fled to the refugee camps in Thailand and Vietnam. In the refugee camps, education was limited, and parents had to pay for their children to attend school. The opportunity for the Hmong to learn and acquire Thai instruction was not possible or affordable to most families. In the United States, the opportunity to learn the English language, history, and culture was possible, but Hmong students' cultural and linguistic differences affected their ability to succeed in school (Mahowald & Loughnane, 2016). Hmong American students have experienced difficulties adjusting to the American educational system due to living and learning styles of their traditional Hmong culture (Romstad & Xiong, 2017). Thus, the cultural and linguistic differences of Hmong students have been found to affect their ability to learn.

This difference in culture and language poses learning challenges for Hmong students and has been found to limit Hmong students' access to standard instructional practices (Lee, Oi-Yeung Lam, & Madyun, 2017; Mahowald & Loughnane, 2016; Romstad & Xiong, 2017). Culturally, the Hmong have a rich history of oral storytelling where knowledge is passed from generation to generation through words and memory (Carpenter-Aeby et al., 2014a). Rather than the use of text, Hmong students learned everything orally from their elders and by observation (Yang, 2012). Hmong students, therefore, rely on language skills such as oral storytelling, memorization, and mimicking to understand concepts. However, in the American school setting, Hmong students often experience a culture of standard-based instructional practice focused more on perceiving analogies and relationships and understanding higher levels of abstraction (Mahowald & Loughnane, 2016). One example is that all students are required to understand and express abstract concepts in contemporary American school, but abstract concepts are difficult for Hmong students to master because Hmong students require the use of visual references and language skills to help them understand abstract academic topics (Mahowald & Loughnane, 2016). Thus, educators are not properly equipped to address the cultural dynamics of Hmong students because white middle-class values are dominant in the school setting (Carpenter-Aeby et al., 2014a).

Linguistically, as English language learners, Hmong students face challenges in the acquisition of English as a new language (Mahowald & Loughnane, 2016). The language structure between the Hmong language and the English language accounts for perceived discrepancies in achievement of Hmong students. Although the English language derived meaning internally using sentence structure, grammar, tense markers, plurals, prefixes, and suffixes, the Hmong language derived meaning externally using word order and concepts or combination of words (Lee et al., 2017; Mahowald & Loughnane, 2016). The absence of the past, present, and future tense markers in the Hmong language leads to difficulties in learning English and understanding science concepts.

Hmong Learners and Science

The participants for this study consisted of Hmong students in biology courses at the high school level. To understand what it means to be a Hmong learner in science, Hmong cultural values and their past and present achievements in science must be understood. The achievement of Hmong students in science provides grounds for understanding Hmong students' perceptions about learning science. Therefore, this section includes a review of current research related to the Hmong culture and science learning, Hmong science achievement and careers, and Hmong students' perceptions about learning science.

Hmong culture and science learning. To further understand how Hmong students learn, the culture of the Hmong people must be understood. Hmong cultural values include the importance of family, family cohesiveness, and interdependence (McCall & Vang, 2012). The importance of family is valued through marriage and raising children because Hmong children have an obligation to provide for their aging parents. The youngest son has the obligation to live with and care for his parents until their deaths. Hmong children over the age of 18 will often continue to live with their parents until they have families of their own. The benefit of living with parents is to gain the skills, customs, and traditions that are passed down from father to son or mother to daughter. The importance of family allows Hmong students to learn about the Hmong culture and to acquire life skills orally from their elders and through observation of their elders (Yang, 2012). Thus, Hmong children become learners through direct teaching from their parents, grandparents, aunts and uncles, cousins, and older siblings.

The importance of *family cohesiveness* is a cultural value because families historically practiced an isolated and agricultural lifestyle in order to survive in China, Laos, Vietnam, and Thailand. A key component of family cohesiveness is the Hmong clan system and the patriarchal family structure. The clan system is based on the last names of the male (McCall & Vang, 2012). When a Hmong woman marries a Hmong man, she marries into her husband's clan. In this structure, the husband is the head of the household and is the authoritative decision maker. The cohesiveness of the clan system allows the Hmong people to seek help from their clan members and the Hmong community. Although family cohesiveness is beneficial for the survival of the Hmong and allows a patriarchal system of males to run the daily political, cultural, social and economic needs of the family, it also has hindered educational opportunities (Lee et al., 2017; Lor, 2013). The hindrance of opportunities included disadvantaged communities and female advancement. In terms of disadvantaged communities, a clan-based ethnic community could isolate Hmong from valued resources outside the community and leave them to rely upon a disadvantaged community (Lee et al., 2017). Thus, disadvantaged Hmong communities can be damaging for Hmong students' access to equitable educational experiences and outcomes. In terms of female advancement, the importance of raising a highly educated son is more valuable in this culture than raising a highly educated daughter because the son will stay in the family while the daughter will marry. Thus, education is valued more for sons than for daughters. However, this practice is slowly changing because as life in America changes, parental thinking and practices have also changed to support all children regardless of gender (Carpenter-Aeby et al., 2014a). The emergence of educated Hmong women is a fundamental change to the Hmong culture and a movement away from a patriarchal community (Lor, 2013). The support of both sons and daughters in obtaining a quality education supports the family cohesiveness of the Hmong community.

Interdependence is another important factor, which involves relying on others in the family to uphold their responsibilities so that everyone is accountable for the family's wellbeing. The Hmong's cultural upbringing is centered on the idea that family comes first before other responsibilities and interests (McCall & Vang, 2013). Therefore, Hmong children's responsibilities in their family are a priority over friends, extra-curricular activities, and homework. For example, Hmong students' obligations to cook, complete household chores, care for younger siblings, help parents with English interpretation in the community, and work to financially support the family often interfere with their schoolwork and extracurricular activities (Dung et al., 2012). The family obligations of Hmong students may sometimes contribute to their academic struggles and social isolation in school. Overall, Hmong students are obligated to uphold expectations for themselves and from their families, clan, and Hmong community, and they often feel pressured to do well culturally and academically (Xiong, & Lee, 2011).

In relation to the Hmong culture and science learning, the Hmong language does not include an abundance of medical terms as is found in the English language (Cobb, 2010). Some scientific terminologies have no words in the Hmong language. For example, the Hmong language does not have words or direct translations associated with certain internal organs (Cobb, 2010). In addition, scientific English meaning can be lost in translation when translated into Hmong and lead to misconceptions or misunderstanding. For Hmong students who are learning science, they often have difficulty understanding a concept that is not present in their everyday lives.

Science achievement and careers. The Hmong community value advancements in education and careers. Hmong family considered education as opportunities for better employment, a higher standard of living, and to ameliorate parental concerns and societal prejudices (Carpenter-Aeby et al., 2014a). However, differences exist in the educational achievement and attainment of Asian minority groups. One difference is that the Northeast Asian groups of Asian Indians, Chinese, Japanese, and Koreans attain higher high school graduation rates than the Southeast Asian groups of Cambodians, Hmong, Laotians, and Vietnamese (Iannarelli, 2014). Specifically to Southeast Asians, Vietnamese students outperform their Cambodians, Laotians, and Hmong counterparts. Hmong students possessed unique cultural experiences that influence their educational achievement. Thus, in terms of educational achievement and attainment, Hmong students significantly lag behind other southeast ethnic groups (Iannarelli, 2014).

Few studies examined the context of Hmong American on academic achievement and educational outcomes (Lee et al., 2017). Several reasons have emerged from the research literature about why Hmong students lag behind other ethnic groups in education. One reason is because most Hmong students do not plan on continuing their postsecondary education. Hmong children exhibit a strong work ethic, and most young Hmong children choose to enter the workforce upon graduating from high school instead of obtaining a post-secondary education (Lor, 2013). In Vietnam, the Hmong have the lowest proportion of workers in state sectors and private enterprises, but the highest proportion in household enterprises (Luong & Nieke, 2013). Therefore, Hmong students may not feel confident in pursuing careers in science because they are afraid of failing. Another reason Hmong students may lag behind other students in science is because of the lack of support they receive at school to pursue science education and careers after high school. Also, many teachers believe that Hmong students are not equipped with the proper intelligence to excel in science so Hmong students are discouraged from pursuing science careers (Upadhyay, 2009). Similarly, Hmong male students have a negative stereotyped in U.S. schools and society with the belief that they are part of a disaffected underclass where "its members do not place a high value on formal education" and thus are less capable than White students (Endo, 2017, p. 594). In pursuing science careers beyond high school, 64.33% of Hmong students (72.41% females and 56.25% males) indicated that their teachers encouraged them to continue their education (Iannarelli, 2014). Likewise, 35.67% indicated that their teachers would not recommend a career in science. One reason why Hmong students continue to pursue science careers is because they do well in high school and are encouraged by their teachers (Iannarelli, 2014). Therefore, the science achievement of Hmong students is reflective of their ability to do well in science. Their poor performance in science may be an indicator of the low percentage of Hmong men and women in science occupations. In a recent study, only 20% of the Hmong populations were employed in science occupations in comparison to 36% of the U.S. population (Vang, 2013). A recent report indicated that 262 Hmong students had earned a doctorate degree in medicine, osteopathy, pharmacy, dentistry, dental surgery, podiatry, optometry, and chiropractic (Hmong Christian Fellowship, 2014). In comparison to the Hmong population of 260,073; only 0.1% obtained professional degrees in science (Pfeifer, 2013). Thus, science achievement and career is relatively low for the Hmong people.

When the Hmong first arrived in the United States as refugees in 1975, the language gap was a barrier to Hmong students' success in school. Only students who excelled in mathematics and science were able to obtain doctorate degrees or professional degrees in medicine. The first Hmong medical doctor was Dr. Long Thao in 1988 from Southern Illinois University School of Medicine (Hmong Christian Fellowship, 2014). In 2014, 39 years after arriving in the United States, the language gap has narrowed significantly as more Hmong students have learned to speak English fluently. However, Hmong students still struggle with learning science. Although their use of English, educational attendance, and educational attainment has improved, the Hmong still lag behind other ethnic groups in science (Lee et al., 2017; Iannarelli, 2014; Romstad & Xiong, 2017; Xiong & Lam, 2013). Factors such as socioeconomic disadvantage, poverty, and parents' lack of formal educational experiences is an explanation Hmong students' poor educational achievement and attainment, and makes them one of the underperforming groups in terms of educational outcomes (Lee et al., 2017, Romstad & Xiong, 2017, Xiong & Lam, 2013).

Perceptions of learning science. The Hmong's perceptions of learning science are evident in their adaptive livelihood of farming, husbandry, hunting, fishing, and foraging. In Southeast Asia, current and past, Hmong families have practiced survival farming to provide for their families (Carpenter-Aeby et al., 2014a; Luong & Nieke, 2013). Although agriculture was predominately practiced from one generation to another generation, the science behind germinating and yielding the best crop went unnoticed. With no formal education and less access to science learning, Hmong students may view science learning with an internal approach because they have had to learn concepts that they had never heard of before in their lives (Luong & Nieke, 2013). An internal approach is the lived experiences that Hmong students know and are accustomed to seeing in their culture. For example, Hmong farmers practiced selective breeding to yield the traits they wanted in their pigs and poultry or corn and rice. Although the desirable trait is noticeable to Hmong farmers, the terminology of selective breeding remains unfamiliar to them. Hmong students' understanding of science is based on their lived experiences, which is shared by their parents (Dung et al., 2012). Their perceptions of learning science are based on what they can see and what they obtain as results. Rather than depending on a central phenomenon to explain new knowledge, Hmong students depend on cultural and social relations and geographical community patterns for their acquisition of knowledge (Luong & Nieke, 2013). In other words, the learning and experience of Hmong student emerges from personal interaction between the learner and the external environment.

Because Hmong students retain knowledge from their communities and families, they may develop misconceptions when the knowledge of science taught in school is different from the prior knowledge taught at home. In school, if Hmong students perceive that the environment is hostile to their traditions and beliefs, their sense of well-being may be diminished (Carpenter-Aeby, et al., 2014a). Thus, Hmong students may feel that science may not support the beliefs and behaviors they have witnessed in the Hmong community. When the learning of science in school is not conducive to competent functioning in the Hmong community, students may experience stress that affects their academic performance (McCall & Vang, 2012). In addition, not understanding a different worldview may generate misconceptions and misunderstandings about science for Hmong students and may lead to unacceptable explanations from their teachers. Therefore, teachers need to be supportive when a new concept arises that is inconsistent with the schema of Hmong students (McCall & Vang, 2012). Rather than criticize Hmong students, teachers need to guide Hmong students in understanding and accepting conceptual changes related to science learning. However, little is known regarding Hmong students' perceptions of learning science in educational settings.

Hmong Learners and Technology Use and Acceptance

The Hmong's settlement pattern, livelihoods, and culture have contributed to their limited technology learning. Little research has been found that is related to how the Hmong use, accept, and perceive technology use. One study suggested that isolation is one reason for their limited technology learning (Luong & Nieke, 2013). The Hmong settled in the rugged uplands or highlands of China, Laos, Vietnam, and Thailand, where development was limited, and many of the students and their families had limited access to information sources like television, radio, and newspapers (Luong & Nieke, 2013). Their isolation has also hindered Hmong communication with other ethnic groups in society. Furthermore, settlement isolation generated closed ethnic traditions among in the Hmong culture (Luong & Nieke, 2013). In America, isolation is still prevalent in the Hmong community because family harmony and unity are important to the Hmong people. Beginning in a new country with a new language, the Hmong people still settled or relocated near their families to provide social support and increase the likelihood of successfully acculturation in America (Aeby et al., 2014a). The Hmong settlement in America is also isolated from the American culture, and that isolation hinders communication between Hmong youth and American youth. Hmong youth often do not reveal their beliefs, ideas, skill sets, and comments to American classmates because of their fear of reprisals and stereotypical comments made about them from their peers (Aeby et al., 2014a). In addition, isolation also restricts Hmong students because they do not have access to the activities and resources in which mainstream American students engage (Lee & Hawkins, 2008).

Although research shows that shows economic opportunities are limited for Hmong students because of poor social communication and information access (Luong & Nieke, 2013), no research could be found about how Hmong students view technology use or its importance. One researcher described the access to technology that Hmong students have at home but did not discuss the importance of technology use (Dung et al., 2012). Although Hmong students have access to and are engaged with technologies to watch television, surf the Internet, and play video games; the lack of parental screen time monitoring encourages Hmong children to use these technologies for entertainment purposes rather than educational purposes or school-related activities (Dung et al., 2012). Therefore, little is known about Hmong students' views of technology used for educational purposes.

Social Influences Unique to Hmong Learners

Social factors such as refugee status, poverty, and cultural norms affect the learning abilities of Hmong students in the United States (Boyer & Tracz, 2014; Lee et al., 2017). Social influences unique to Hmong learners involve their background as refugees. As refugees to the United States, the Hmong obtained limited human resources, and their agricultural work experiences are not transferable to the industrial and educational experiences in the United States (Dung et al., 2012). As refugees, Hmong parents also have little education and cannot prepare their children to excel in school (Boyer & Tracz, 2014). In one study, the average educational experience of Hmong refugees was found to be 1.7 years, which indicated that Hmong are the least educated refugees among Laotian, Cambodian, and Vietnamese refugees (Her, 2014). Hmong students of refugee parents often start school with an educational deficit that contributes to their low grades and achievement gaps. This refugee status also contributes to the fact that the Hmong have the "highest proportion of family income below the federal poverty line" compared to other Southeast Asian families or Asian Americans (Dung et al., 2012, p. 2).

Some Hmong learners are also impacted socially due to poverty as 25% of the Hmong population lives in poverty (Dung et al., 2012; Pfeifer, 2013). The Hmong are the poorest and most highly unemployed immigrants in the United States (Lee et al., 2017). In Wisconsin, 21% of Hmong students under the age of 18 live in poverty (Pfeifer, 2013). Living in poverty leads to environmental influences such as poor housing and neighborhoods and fewer resources (age-appropriate toys, reading level books, and computer with internet access) that impact children's development and school readiness (Dung et al., 2012). Crowded space at home leaves no room or space for Hmong children to do homework. Hmong students living in crowded space rely on using the living room to study and complete homework. The family's physical home environment does not equip Hmong students with the proper resource to do well in school.

Although refugee status and poverty have contributed to challenges in school for Hmong students, their cultural values also serve as a barrier to academic achievement (Ngo & Leet-Otley, 2011). In addition, Hmong communities facilitate the transmission of norms and expectations (Lee et al., 2017). Cultural norms, such as early marriage and pregnancies, often result in Hmong students dropping out of school (Boyer & Tracz, 2014). In Laos and Thailand, Hmong girls often marry between the ages of 13 and 16 to help out on the farm (Ngo, & Leet-Otley, 2011). In the United States, high school students as young as 16 marry by choice rather than by cultural obligation or tradition.

Most Hmong girls are already married before they turn 18 years old (Ngo & Leet-Otley, 2011). Therefore, early marriage and pregnancies may serve as a barrier to student learning. Early marriage and pregnancies may make it difficult for Hmong students to obtain a high school diploma because they have to balance childrearing and adult responsibilities with schoolwork. In a biographical and ethnographic study of Hmong women, when Hmong girls get married they must take care of the household and be responsible for cooking, cleaning, and taking care of younger siblings as well as their in-laws (Lor, 2013). The husband often drops out of school to provide financial stability while the wife drops out of school to care for the child. On the other hand, a shared role of childrearing practices between the young married couples and their parents has allowed some young married couples to stay in school and attend college (Ngo & Leet-Otley, 2011). The acceptance of early marriage in the Hmong culture is a choice unique to Hmong learners that may impact whether or not they drop out of school or continue with their education. Thus, refugee status, socioeconomic background, and cultural norms of the Hmong people have often negatively affected the educational outcomes of Hmong American students.

Personal Factors Unique to Hmong Learners

A number of personal factors affect Hmong students in school. Personal factors such as stereotypes, language, generation, culture, education, learning styles, and self-efficacy of social skills affect the learning abilities of Hmong students in the United States (Boyer & Tracz, 2014; Lee et al., 2017). The first personal factor that impacts Hmong learners are the misperceptions about Asian-American students. The stereotype of Asian-Americans as high achieving students negatively affects Hmong learners (Boyer & Tracz, 2014; Her, 2014). Although Asian Americans have the highest percentage of bachelor degrees among minority groups, this percentage may be misleading because other subgroups of Asian Americans are performing lower (Xiong & Lee, 2011). The Hmong struggle academically and have a lower bachelor degree attainment than most Asian groups (Dung et al., 2012). Hmong students are not advanced learners when compared to other Asian counterparts such as Japanese-Americans and Chinese-Americans (Her, 2014). This misunderstanding often leads educators to assume that Hmong students do not need help, and they are often overlooked because educators developed a misperception that Hmong students are Asian Americans and they do not need educational support (Boyer & Tracz, 2014; Her, 2014; McCall & Vang, 2012). Thus, Hmong students are often underrepresented in relation to Chinese or Japanese students, and they become disenchanted with school because educators fail to provide support for their learning. The support Hmong students need in school is more than other Asian counterparts. The model minority stereotyping of all Asian Americans into one group has been beneficial to some Asian American community and harmful to some Asian American community because the differences among various ethnic groups are not considered (Her, 2014).

Another personal factor that affects Hmong students in school is their lack of English proficiency. In terms of language, the Hmong population is less proficient in English and has less formal education than other Asian ethnic groups (McCall & Vang, 2012). College readiness studies indicated that Hmong Americans are the least prepared for college level English (Her, 2014). Today, Hmong students' English language acquisition in school is a contributing factor to their learning.

Similar to English proficiency, another factor that affects Hmong students in school is the generation gap. Language acquisition plays a role in this generation gap. Generations of Hmong in the United States include Generation 1, Generation 1.5, and Generation 2 (Huster, 2012). Hmong Generation 1 came to the United States as adults (16 or older), and the majority were illiterate or acquired limited English proficiency (Lee & Green, 2010). On the other hand, some Hmong Generation 1 students were proficient in English and obtained college degrees. Hmong Generation 1.5 students included foreign born children who immigrated to the United States between the ages of two and 12 and integrated into the American culture. Hmong Generation 1.5 students speak fluent English and are the most prevalent generation found in high schools and colleges (Huster, 2012). Similarly, Hmong Generation 2 students are native born American citizens or foreign born who immigrated to the United States between the ages of one month to two years old (Lee & Green, 2010). The majority of Hmong Generation 2 students are currently in primary school while some are in secondary or postsecondary schools. Currently, no research has been found indicating that the language acquisition of these three Hmong generation correlates to educational success. Although some Generation 1, Generation 1.5, and Generation 2 Hmong students have pursued higher education and professional careers, some members in each generation have dropped out of school or are not college ready (Lee & Green, 2010). In general, Generation 1.5 and

Generation 2 Hmong students have been provided with the opportunity to learn the American language and culture and are more likely to achieve educational success.

Another personal factor unique to Hmong students is acculturation into the American culture in face of obligations to the Hmong culture. Due to their family's cultural background, Hmong students often feel a cultural distance from the American school culture (Supple et al., 2010). One challenge is that Hmong students try to adopt the social patterns, norms, and values of their non-Hmong peers at school while being pressured to learn and preserve Hmong cultural traditions at home (McCall & Vang, 2012; Supple et al., 2010). Hmong students faced a conflicting dilemma where they need to find a balance between the American culture and the Hmong culture in order to be successful at school and at home. However, finding this balance often leads to stress because Hmong parents do not understand why their children feel the need to adapt to the American culture. For Hmong students to succeed in mainstream society, they must integrate into the American culture in order to acquire social mobility without giving up their Hmong identity (Supple et al., 2010). Although Hmong students need to understand their parents' values and their culture, Hmong parents also need to understand both cultures and support their children in American society. Even within two different cultures, Hmong students can develop their English language skills at school and maintain their Hmong language at home in order to do well academically.

Not many Hmong students and parents understand the American educational system. First generation Hmong students are the first ones in their family to attend primary schools, secondary schools, and postsecondary schools. As first generation students, their parents do not have an adequate education or experiences in the American educational system to provide support (Dung et al., 2012; Supple et al., 2010). Therefore, first generation Hmong students often have limited knowledge about the American educational system and lack essential skills to excel in high school and in college (Xiong, & Lee, 2011). In addition, first generation Hmong students may not know how to seek out the resources to help them go on to college and to seek out available funding (Lor, 2013). This lack of knowledge and skills may be passed on to their children with similar effects. For Hmong students, they find a lack of knowledge and support in seeking assistance with study skills, academic advising, career planning, and balancing schoolwork. Thus, having little formal education, limited English ability, and unfamiliarity with American culture affect the learning of Hmong students (Supple et al., 2010).

Learning styles is yet another personal factor unique to Hmong students. The most urgent educational needs of Hmong refugee students are language acquisition and psychosocial adjustment (McCall & Vang, 2012). One instructional adjustment that teachers may modify to meet the needs of Hmong students is to teach Hmong cultural values and changes in their culture due to living in a new country. No research has been found to indicate that Hmong students have a particular learning pattern or style that is different from other English language learners. The learning styles of Hmong students require further investigation.

A lack of social skills due to poverty is another contributing factor to Hmong students' learning in school. Children from middle class families who are taught in a formal school environment that fosters talents and structured activities are more likely to perform better in school than children from poor families with limited skills and talents (Dung et al., 2012). On the other hand, Hmong students' home environment is often filled with unstructured activities as parents are busy working to provide for the family. With limited adult supervision at home, Hmong students are more likely engaged in free play rather than enrolled in after school activities (Dung et al., 2012). Although Hmong students have learned the social skills to interact within their family, they lack the social skills to interact at school with other ethnic groups. Therefore, Hmong students are not cultivated in their home environment to thrive in the school environment. Hmong students have acquired non-cognitive factors that reflect specific behaviors and attitudes of interdependency, but they have not acquired cognitive factors such as content knowledge and academic skills and strategies that they can utilize in an educational setting (Her, 2014).

Various personal factors affect the self-efficacy of Hmong students. These personal factors include stereotyping, language and culture, education, learning styles, and social skills, and they often lead to relatively low feelings of connection or support from school and home for Hmong students (Supple et al., 2010). The stereotyping of high academic achievement affects Hmong student's self-efficacy because they see school failure and high dropout rates rather than school success and high graduation rates. Their limited use of the English language also contributes to feelings of cultural distance from their peers at school. In addition, the difference in language makes Hmong students appear incompetent in relation to their English language skills. Although Hmong students can speak English without a distinctive pronunciation or accent, they still struggle with grammar, academic vocabulary, and English morphology and syntax (Huster, 2012). Some of the language challenges they face include irregular nouns and verbs, grammatical inconsistencies, subject-verb agreement errors, and difficulty with vocabulary. Hmong students have reported that they have trouble answering questions because they cannot fully comprehend some words their teachers are saying (Huster, 2012). In addition, Hmong students are concerned that they may not be able to use English to a high level of confidence and effectiveness because they have a limited vocabulary.

Similarly, differences in culture contributes to making Hmong students feel inferior to their non-Hmong classmates as schools do not connect with their lived experiences or draw upon their cultural funds of knowledge (Upadhyay, 2009). The self-efficacy of Hmong students in relation to doing well in school is affected when they develop feelings of not belonging, experience discrimination, face difficulties with the English language, and feel alienated due to cultural barriers (Supple et al., 2010). In addition, the lack of structure and skills at home also plays a role in Hmong students' self-efficacy to do well at school. These personal factors suggest that school learning becomes disempowering to Hmong students when learning is disconnected to their experiences at home, where the disconnection between home and school is a personal factor that poses a struggle for Hmong students to progress academically (Levy, 2017; Supple et al., 2010; Upadhyay, 2009). Levy (2017) indicated that Hmong students found value, meaning, engagement, and knowledge in the curriculum when it is directly linked to their heritage; and teachers who can find a way to connect content with students' lives are more effective in engaging students and helping students. Hmong students, therefore, may not develop an academic mindset based on personal factors and social influences. Without an academic mindset, Hmong students feel that they do not belong, do not have the ability to improve and succeed academically, and do not see value in their learning (Her, 2014). Thus, educators need to employ strategies to empower Hmong students to feel included, restore their beliefs and confidence in their ability to succeed academically, and establish value in the learning of academic content.

Although some research has been done regarding Hmong learners, much is yet to be understood. The literature review indicated that differences in Hmong students' culture and language, perceptions of learning science, unique social influences, and unique personal factors may limit Hmong students' access to standard educational practices, science learning, and use of technology in the United States. Therefore, a need exists for educators to pay attention to the distinct cultural context and learning styles of Hmong students because some school districts have predominantly white middle class values and are not properly equipped to deal with the cultural dynamic changes (Carpenter-Aeby et al., 2014b). In addition, the learning style of Hmong students is a gap that requires further investigation. No research was found in this review that Hmong students demonstrate particular learning patterns or styles because of their culture, and limited research has been found on Hmong students' perceptions of learning science and technology. Thus, this proposed study may add to the current research about Hmong students and help educators to further understand the ecological and ethno-cultural realities that Hmong students face in school. This gap was addressed by examining Hmong students' perception and teachers' perceptions about teaching strategies or learning styles that support, develop, and sustain the educational achievement of all Hmong students regardless of culture, language, social influences, and personal factors.

Technology Acceptance in High School Science

The conceptual framework for this study was based on the modified TAM of Gu et al. (2013). TAM is the most common model used in information systems field to show the acceptance and use of technology (Adetimirin, 2015). Because this proposed study is about how technology innovations in high school biology courses impact science learning for Hmong students, I reviewed the research related to the acceptance of technology, particularly related to Gu et al's (2013) four constructs of outcome expectancy, TTF, social influence, and personal factors. In this section, I first examined multiple definitions of technology acceptance from the literature. Then I analyzed research related to technology acceptance in high school biology courses and PLTW programs in relation to outcome expectancy, TTF, social influence, and personal factors.

Defining Technology Acceptance

Researchers have proposed many models to examine factors that can help predict students' intention to accept technology use in education. However, for this study, the definition of *technology acceptance* is based on the foundation of the TAM of perceived usefulness, perceived ease of use, attitude, and intention to use. Multiple definitions of technology acceptance were found in the research literature in relation to TAM and technology acceptance in high school science classrooms. Davis and Venkatesh et al.

described technology acceptance as the students' internal beliefs and attitudes on their usage of technology (as cited in Gu et al., 2013, p. 394). Belief is described as subjective norms that allow student to agree or disagree about any behavior, whereas attitude is described as the positive or negative evaluation of specific behaviors, activities, and events by students (Hsu, 2016, p. 490). A student's attitude toward using technology is influence by perceived usefulness and perceived ease of use. Al-Azawi and Lundqvist (2015) suggested that perceived usefulness has a significant impact on accepting a technology and thus explaining a student's attitude. Similarly, perceived ease of use is significant in determining perceived usefulness and students' attitudes toward a technology. Therefore, technology acceptance is a student's engagement in specific behavior due to the student's intention toward the behavior. In other words, a student engages in a learning tool with the expectation of gaining information to improve his or her learning effectiveness or course performance (Gao & Wu, 2015).

Similarly, technology acceptance can be described as making a decision about how and when students will use the new technology (Jung, 2015, p. 226). Again, perceived usefulness and perceived ease of use were measures of students' acceptance of technology usage. Students' perceptions of usefulness and ease of use determine their attitudes toward using a particular technology, and in turn their attitudes determine behavioral intentions to use the technology, which results in the actual use of the technology (Juhary, 2014). Therefore, perceived usefulness and perceived ease of use influence attitude, and attitude influences students' behavioral intentions to use technology. Thus, students with the intention to use a particular technology will most likely use the technology more than students who do not, and students with the perception that a technology is useful and easy to use will develop the intention to use it more than students who do not.

Overall, technology acceptance is the intention to use varying technologies in a manner that is effortless and enhances job performance. A definition of technology acceptance as generated from various literature reviews is that technology acceptance is learner satisfaction in the completion of a learning task (Gao & Wu, 2015; Gu et al., 2013; Hsu, 2016; Jung, 2105). Therefore, learner satisfaction occurs when learning needs are met and the satisfaction level of acquiring advantageous learning is based on the learner's beliefs and attitudes. Based on the definitions of technology acceptance in the literature, my derived definition of technology acceptance is the way students perceive, accept, and adopt technology use. Thus, when a student accepts a technology, the student is willing to use the technology.

Technology fit is an important component in understanding students' acceptance of technology. Technology fit research is often related to educational Web 2.0 technologies, learning management systems (LMS), social media, and how students use technology to communicate. In relation to this study, technology-fit includes looking at bio-technology in addition to other educational technology components. Students have capabilities to use computer technologies to complete certain tasks based on their confidence in making successful use of the technology (Jung, 2015, p. 227). For this study, educational technology consisted of using web tools, computer, simulations, and non-science specific electronics. Educational technology is defined as a range of digital hardware and software used to support teaching and learning such as desktop, laptop, and handheld computer and applications (Wu, Hsu, & Hwang, 2008, p. 65). Likewise, biology technology for this study consisted of science technology tools such as Vernier probes tools, LoggerPro data collection and analysis software, and general-use electronic laboratory equipment such as wet and dry heating baths, balances and scale, incubators, drying ovens, rockers and vortexers, mini and microcentrifuges, gel electrophoresis, and gel imaging systems and software.

Technology Acceptance in High School Biology Courses

High school students often accept the use of technology for learning. In science, technology plays an important role in integrating science skills and mediating authentic experiences in the classroom. Research shows that computer and general technology helps teachers and students become aware of the functions and capacity of technology and their benefits for students' learning (Puhek et al., 2013). Students' acceptance of technology may depend on outcome expectancy, task-technology fit, social influence, and personal factors. In terms of outcome expectancy, when a new technology is introduced, students will accept the technology even if it is harder to use if they considered the technology to be useful (Yusoff et al., 2011). In a study by Thompson (2012), TTF allowed high school students to use technology for subject specific learning tools more effectively in STEM courses than in social sciences courses or in extracurricular subjects. The success and failure of a technology depends on how well students like the technology, how easy it is to use, and the technology's effectiveness (Yusoff et al., 2011). If the technology is useful, students will accept it, but if students do not perceive the technology as useful, they will not use it, even if it is easy to use. Sometimes students are not interested in using the technology because they do not see the same potential in the technology as their teachers do (Yusoff et al., 2011).

Although limited research was found in this review regarding technology acceptance in high school biology courses, one research study that Giannakos (2014) conducted shows that high school computer science courses were focused on outcome expectancy and social influence. Although computer science courses are not the same as biology courses, the technology used in computer science courses is relevant to the technology used in PLTW biomedical and engineering programs. In this study, Giannakos (2014) explored student intentions to study computer science and identified the differences among ICT, and programming courses. Ginnakos collected six data sets that included performance expectancy, satisfaction, social influence, self-efficacy, perceived behavioral control, and intention to study computer science in relation to an ICT course offered at a high school in northwestern Greece that included 26 students. Giannakos found that outcome or performance expectancy and social influence have a significant positive effect on students' intention to study ICT. Students expressed high satisfaction with the ICT and programming course, and they reported positive insights about their experiences in computer science, particularly in relation to control, usability and usefulness.

Outcome expectancy. The outcome expectancy of a technology by students will likely determine the acceptance of the technology. In a study about students' acceptance of technology, Horzum, Öztürk, Bektaş, Güngören, and Çakır (2014) found that attitude and intention are significantly influenced by outcome expectancy. In another study, Pukek et al. (2013) found that science students accepted virtual field trips in science classroom because they believed the technology was usable and effective for their understanding of natural experiences. In other research, Lawanto et al. (2012) found that students with high expectancy for success were able to achieve success while students that do not have a high expectancy for success were not successful in their engineering design tasks. These studies indicated a strong expectancy for success relationship between students' design activities interest and their design task completion. If students are not interested in the design tasks, their expectancy for success may decrease. If outcome expectancy decreases, attitudes toward the technology may be negative and there may be less intention to use the technology. Besides expectancy for success in terms of attitude and intention, outcome expectancy also includes cognitive and affective outcomes. In a case study that included 326 high school students from various disciplines, Thompson (2012) found that using technology integrated instructional classroom strategies and technology productivity tools contributed to students' cognitive and affective outcomes. The outcomes included improved information literacy and attitudes toward computer technology. In addition, 80% of high school students provided positive feedback about the affective outcome of a web-based library in answering relevant course questions. Furthermore, in addition to expectancy for success and cognitive and affective outcomes, the benefit of a technology may also be perceived as an outcome expectancy that contributes to technology acceptance. In a study of mobile learning, Cheung, Yuen, and Tsang (2011) found that students accepted mobile devices for learning due to the technological feasibility and benefits of mobile learning to meet their instructional needs in a flexible and ubiquitous learning environment. One benefit of mobile learning that contributed to outcome expectancy is that mobile learning allows for learning anywhere, anytime, and on any devices (Cheung et al., 2011). Thus, secondary school students' acceptance of technology may depend on how they perceive the outcome and benefits of the use of the technology.

Although technology contributes to positive outcomes, it also contributes to negative outcomes. The difficulty of using web-based tools means that students may not be proficient in searching for syntax or methods, they may not be familiar with the software interface, and insufficient resources are available for students to use (Güngören, Bektaş, Öztürk, & Horzum, 2014). Thus, students facing cognitive obstacles in working with the technology may likely experience poor outcome expectancy, and they may require additional specific instruction about its use in order to be successful.

Task-technology fit. Research shows that technology acceptance is influenced by TTF. The focus of this study is on high school science, but studies are scarce relating to TTF for high school students, particularly for high school biology students. However, studies were found relating to TTF in higher education. Goa and Wu (2015) conducted an exploratory field study using a survey with a 7-point differential scale of 101 high school and college students in various disciplines between the age of 18 and 21. They found that perceived ease of use has a positive correlation with students' use of Moodle. Students commented that Moodle was easy to use and helped them stay on track with classwork. The ease of use of Moodle allowed students to view Moodle as an appropriate technology to fit their learning needs. In other research, Ngafeeson and Sun (2015) surveyed 158 undergraduate students to investigate the impact of e-textbook on user acceptance and found that technology innovativeness, subjective norm, perceived ease of use, and perceived usefulness has both a direct and indirect influence on their intention to use e-textbooks. Ngafeeson and Sun suggested that the decision to use a technology-based device related to ease of use is determined by students trying out new technologies, and that the "more e-textbooks are perceived as easy to use, the greater the likelihood of being accepted and used (p. 65). Thus, similar to Moodle, students view e-textbook as a TTF for learning because it is easy to use and serves the same purpose as a standard textbook. In another study, Neufeld and Delcore (2018) found value in the use of tablets for information search, retrieval, storage, reading, annotation, document composition, and collaboration. Thus, students adopt the use of tablets for functionality and the role it plays in fulfilling their computer needs. In addition, task fit or perceived ease of use is one of the strongest determinants of technology use, and students' exposure to technology may influence acceptance, familiarity, adoption, and behavioral use of technology.

A review of the research about high school science indicated that Moodle and Google Docs are TTF tools that teachers use to organize science course and share content information with students for availability and accessibility at home (& Horejsi, 2013). In addition, students can collect and share data using Google Forms, and manipulate data compiled from other students in class. Therefore, Google Docs is a web tool that supports learning and is a TTF for science classrooms. In other related research, Güngören et al. (2014) studied 400 ninth grade high students' acceptance of tablet PCs and found that students use mobile technologies in education environments because mobile devices attract student attention, motivate students, facilitate flexible learning, and allow for quality time management in course work. Students' acceptance of technology is important in regards to how they use the technology to fit relevant coursework. In using Web-Quest Library, the e-library was relevant to the study of science because it contained 75% of science-related data items (Güngören et al., 2014, p. 616). In addition, 70% of the students provided positive feedback about their perceived ease of use and enjoyment with the e-library. Although studies have been done related to technology use in high school biology, no task-fit studies of biology technology used in PLTW high school science courses were found in this review.

Social influence. A number of studies explained the importance of group pressure in students' acceptance of technology, but limited studies were found on social influence in high school biology. Svendsen Johnsen, Almås-Sørensen, and Vittersø (2013) conducted a TAM study on personality and group pressure that included randomly-selected 15 years old students and found that students who are open to technology experiences are less influenced by peer pressure than students who are not as open to these experiences. The acceptance of technology is influenced by the opinions of others when openness to experience, emotional stability, interest, and personality are low (Svendsen et al., 2013). When teachers and school board members consider the iPad as a useful learning tool, this factor positively affects students' intention use and actual use of the technology (Courtois, Montrieux, De Grove, Raes, De Marez, & Schellens, 2014).

Some students may feel obligated to use the technology that their teachers use rather than using technology based on their free will (Courtois et al., 2014). Thus, social influences have various origins, including peers, teachers, and school board members.

Personal factors. Personal factors play a significant role in students' acceptance of technology in high school. Students cannot learn properly if they feel that personal factors prevent them from achieving their objectives. Some personal factors that may lead to student dissatisfaction include self-motivation, difficulty in new knowledge construction without direct guidance, and lack of technology self-efficacy (Al-Azawei & Lundqvist, 2015). In terms of motivation, students who displayed a negative stance from day one in using technology were less likely to continue using the technology (Courtois et al., 2014). In a longitudinal study, Courtois et al. (2014) found that students who have a favorable position toward using a tablet as a learning tool are more prone to develop specific skills and establish high expectations toward using technology at school. Thus, a stronger perceived behavior would give rise to developing a more positive attitude. Even when using a new technology system, students are motivated to learn when they remain positive because they easily adapt to different learning environment, even if the learning environment does not address their individual preferences in relation to technology use (Al-Azawei & Lundqvist, 2015). In addition, students often have a positive learning experience with difficult technologies because they learn and apply new knowledge without a negative effect on their motivation to learn (Lin & Lin, 2016).

In terms of a lack of guidance, Lin and Lin (2016) explored how to learn nanotechnology through texts and comics and found that students are not satisfied with technology use because it is too challenging for them and they do not have the appropriate background to fully understand the technology so they give up very quickly. Lin and Lin also found that students are less comfortable using the technology due to limited prior experiences and support from their teachers. In other research, students believed that they become more satisfied when they use computers and ICT tools and when they are provided with training to handle technical difficulties (Kubiatko, Haláková, Nagyová, & Nagy, 2011). Thus, background knowledge and lack of guidance may affect self-efficacy and students' motivation to use technology.

Although lack of guidance affects satisfaction, lack of guidance may be related to self-efficacy, which is defined as students' cognitive beliefs affecting their behavior when using a technology (Wu, Tennyson, & Hsia, 2010, p. 156). Horzum et al. (2014) conducted a quantitative study about high school students tablet computer acceptance and readiness and found that high school students' self-efficacy has a positive influence on their attitudes toward using tablet PCs. Horzum et al. discovered that the self-efficacy of secondary school students toward tablet PCs is above the norm and that high school students know how to use table PCs because they are knowledgeable about the tool and are considered to be tablet PC ready. Horzum et al. also found that self-efficacy accounted for 78% of students' perceived ease of use regarding table PCs. These findings indicate that students established high self-efficacy and acceptance levels for using table PCs. In contrast, students may be unsatisfied if they are not confident enough to use the technology and if the technology represents new experience for them (Al-Azawei & Lundqvist, 2015). Overall, motivation, guidance, and self-efficacy all play an important role in a student's acceptance of technology use. The connection between lack of guidance and self-efficacy is that when students perceive a lack of support from teachers in terms of technology use and they already have low self-efficacy about the technology, they may not be motivated to use the technology. On the other hand, students may be motivated to use technology with support and guidance from their teachers, which has been shown to raise the confidence level of low self-efficacy students and motivate them to use the technology knowing that they have help.

Technology Acceptance in Project Lead the Way Program

PLTW is a nonprofit organization that provides elementary, middle, and high school students with hands-on, project-based, and technology-based accredited engineering and science curriculum (Cahill, 2016; McMullin & Reeve, 2014; Ralston, Hieb & Rivoli, 2013). The purposes of PLTW is to develop technologically literate high school students; generate interest in science, technology, engineering, and mathematic fields; and encourage students to pursue career pathways in engineering and biomedical science (Werner & Kelley, 2011). The problem-based and technology-based instructional model of PLTW helps "students build on their understanding and gain independence in the learning process, provides them with opportunities to transfer knowledge, and engages them as they apply their new learning to a relevant problem" (Cahill, 2016, p. 27). In addition, the emphasis of PLTW curriculum is to teach both students and teachers how to engage in the field of engineering and biomedical science (McMullin & Reeve, 2014).

The acceptance of technology in PLTW programs may relate to the effective use of technology in the program. PLTW has been proven to prepare high school students with skills to transition in college or university engineering and technology courses (Ralston et al., 2013). In an examination about connecting concepts through problem solving, Dixon and Brown (2012) included 38 PLTW students and 25 mathematics and science students in their study and found that no difference in the performance of non-PLTW students and PLTW students on standardized mathematics and science items, but PLTW students scored higher in overall performance on the design questions. The effectiveness of the PLTW curriculum and the integration of robust technology into the coursework suggested that technology acceptance and use in these programs are positive.

PLTW is relatively new in the United States, and therefore, limited research was found on related findings that may impact high school science education. Although studies about PLTW and its impact on student learning have been limited in scope, McMullin and Reeve (2014) indicated that PLTW research is just now yielding precursory findings on its impact on public education (p. 25). Although some studies on the engineering components of PLTW exist, little or no studies were found on the biological components of PLTW. Therefore, the following sections described both high school students and teachers' acceptance of PLTW within the framework of the TAM components of outcome expectancy, task-technology fit, social influence, and personal factors.

Outcome expectancy. The acceptance of PLTW in schools is based on potential outcomes related to quality teaching and quality instruction. McMullin and Reeve (2014) examined the factors in successful implementation of the PLTW program and found that this program provided a high quality secondary pre-engineering program, teacher professional development, state of the art techniques and technology, and a pathway for students that could lead to a career in engineering or engineering technology. The reasons for implementing PLTW include improving teacher training; improving the delivery of instruction, offering a perceived high quality program; strengthening the schools' STEM curriculum; forming partnerships between schools, industry, and the community; and creating desirable student outcomes (McMullin & Reeve, 2014). In a quantitative study using the data from the Texas Education Agency, (2013) found that students who participated in PLTW courses were more prepared for higher education, obtained higher scores on the state's mathematics assessment, and earned a 13.6% increase in wages following high school graduation than non-PLTW students. In addition, a study of 1,000 PLTW students and 15,000 non-PLTW students in Iowa high schools, Starobin et al. (2013) found that PLTW students demonstrated higher results in two year and four year college enrollment, higher transfer from a community college to a four-year institution, and higher enrollment in a STEM major. In a study about student interests and expectancy for success in relation to creative design activities, Lawanto and Stewardson (2013) found that students perceived the technology in PLTW engineering courses to have attainment, intrinsic, and utility values when students' perceptions of the course activities are important, interesting, and useful. Students' perceptions of PLTW were positive because they believed it is important for them to learn the knowledge and skills taught in these courses and they believed they will be able to use these skills in other courses. In addition, Lawanto and Stewardson found a robust relationship between students' interests in PLTW activities and their expectancy for success in task completion. In another study about student interests and expectancies for success in engineering design activities, Lawanto, Santoso, and Liu (2012) found students' interests in using technology systems and manufacturing processes to complete their task account for 75.8% of expectancy for success. Similar to the studies mentioned above, another study by Capers (2017) found PLTW to improve student motivation and enthusiasm, promote critical thinking and problem solving, provide career awareness and exposure, and increase student interest in math and increase. Thus, according to Capers, PLTW provides a hands-on learning environment with the emphasis on the use of technology to solve real-world application while being relevant to the content and engaging for students. Overall, research studies indicate that PLTW is useful and positive for students. The favorable outcomes of PLTW are that students enroll in higher education courses and STEM majors, demonstrate higher achievement scores, show greater task value and interest, and are better prepared for college and career readiness.

Task-technology fit. Students' acceptance of technology in PLTW may depend on the TTF of the technology that is used in those courses. A study of 31 PLTW high school students found that they accepted the use of technology in their bridge design and marble sorter design because the tools were found to be important and to have utility and a high task value for the completion of the project (Lawanto, Santoso, & Liu, 2012; Lawanto, & Stewardson, 2013). The use of technology systems allowed students to design complex bridges and marble sorters. In this study, the technology met the task requirements of students and had a positive impact on their performance. Lawanto et al. found that students understand the technology-fit connection to the task they are being asked to do in a PLTW class because the technology tools are part of the hands-on program. In relation to biology technology, students cannot complete a task if they do not use the tool. For example, in a study about using web tools to support learning, Brunsell and Horejsi (2013a) noted that some probes such as stream flow rate sensor are used in water to measure the rate of stream flow, and students cannot complete this task if they do not have the sensor. Therefore, the sensor is a TTF for measuring stream flow rate. Although TTF is relevant for biology technology use, TTF may not be true for educational technology use. A virtual lab presented on a computer to calculate flow rate may not be a TTF because students may not know how stream flow was calculated. Students may follow the computer prompt without understanding how the computer program obtained time and distance to calculate flow rate. Thus, students may not know how the computer program arrived at the final answer.

Social influence. In accepting the use of technology in PLTW courses, social influence from the instructor plays a vital role. In a study of urban PLTW students at two high schools in the Midwest, Nathan et al. (2013) found that students' understanding of a network of logic devices called NAND gate technology was not sufficient to carry out the digital mapping. Nathan et al. also found that social interactions between students and teachers support the acceptance of NAND use because students were able to use explicit coordination, projection, and clear identification of the NAND function to carry out the mathematical operations of NAND. Students' use of NAND is heavily influenced by the amount of support they obtain from their instructors. Nathan et al. also discovered that students do not carry out the correct actions and seem adrift when they are working independently, but when the teacher is present, they perform nearly the same task as they would have done in the presence of the teacher. Therefore, the ability of students to carry out the NAND function is influenced by their teacher, which makes it possible for them to carry out the same actions on their own later on in the course. Thus, the social influence of the teacher helps build the self-efficacy of the students to accept and use the NAND gate technology. Overall, students perceive technology differently in the PLTW course when they understand how the tasks are supported in the learning process so they develop a mindset that they can learn how to use technology because their teacher and other classmates can learn how to use it, too.

Teachers also have an influence on students' acceptance of technology and their enrollment in PLTW courses. Students accept their ability to do well in a PLTW course if their teachers endorse their enrollment in the course. In a study about the beliefs and expectations of PLTW and non-PLTW teachers, Nathan, Tran, Atwood, Prevost, and Phelps (2010) found that PLTW teachers compared to Non-PLTW teachers are more likely to endorse students who have a background of strong academic performance over students with weak academic performance, even if students share the same interest level in the course. Nathan et al. also found that students' beliefs in doing well in PLTW courses are influenced by teachers' beliefs and expectations about student learning. A teacher's belief in a student's abilities may improve a student's self-efficacy or confidence to do well in a course. Thus, when teachers believe that students can learn, students also believe they can learn. This finding suggests that a connection exists between the positive influence of teachers and the positive outcomes of students.

The social influence of culture may also play a significant part regarding technology acceptance because the target population is Hmong for this proposed study. Although no studies were found on culture as a social influence of technology acceptance within a PLTW program, the demographics of minority students who enrolled in PLTW are relevant. In a quantitative study about PLTW and non-PLTW student cohorts that Van Overschelde (2013) conducted, the diversity of student participation in PLTW enrollment and the number of economically disadvantaged students increased in the last 5 years. A total of 1,681 Hispanic students, 1,618 White students, and 802 students of other ethnic and racial groups were included in this study. The participation of minority students in PLTW increased by 507% over 5 years compared to the participation of White students (Overschelde, 2013). In addition, economically disadvantaged students increased by 650%. These findings indicate that more ethnic minority and impoverished students are participating in PLTW courses. Based on the lack of research on PLTW, however, more research is needed regarding culture and technology acceptance in science and PLTW.

Personal factors. A number of personal factors influence technology acceptance in PLTW programs. The first factor is how challenged students feel by the task. Students accept the technology used in PLTW because they understand how the use of the tools help them to complete their tasks, and they are motivated because the task is challenging (Lawanto, Santoso, & Liu, 2012). Conversely, other students are reluctant to use PLTW technology to complete their task because they believe it is too challenging and the difficulty level does not motivate them. Another personal factor that influences technology acceptance is student confidence. In a study about engineering design interest and expectancy for success, Lawanto et al. (2012) concluded that "students with high self-belief in their effectiveness or confidence are more likely to believe they will perform better in design tasks" (p. 158). If students believe that their efforts and their use of technology have a positive influence on their learning, they will use the technology to strategically and effectively engage in their learning activities. On the other hand, students with low self-perceptions of their ability to succeed will not perceive the task to be important and may avoid the task rather than complete it (Lawanto et al., 2012). These studies suggest that high perceptions lead to high task value while low perceptions lead to low task value. A student's lack of ability to master a task and a student's lack of self-confidence to perform a task often result in low motivation and expectancy for success (Lawanto et al., 2012). Thus, the level of self-efficacy may be related to students' intrinsic motivation, and their expectancy for success may influence task value development. This finding suggests that self-efficacy is related to outcome expectancy and task-technology fit, which requires further research.

The research on technology acceptance in high school science ranges from the challenges related to the acceptance of tablet devices (Horzum et al., 2014) to challenges related to the acceptance of educational technology and biology technology in biology (Giannakos, 2014; Incantalupo, Treagust, & Koul, 2014, 2014; Ngafeeson & Sun, 2015; Yang et al., 2015; Yapici & Akbayin, 2012). The literature review suggests that concepts such as outcome expectancy, task-technology fit, social influence, and personal factors affect technology acceptance of students. The gap that remains is related to the scarcity of studies on technology acceptance in high school biology courses and in innovative biology courses such as PLTW to increase understanding of a student's acceptance of technological innovation in science education. This gap is important to address because high school students' perceptions of technology acceptance may be different from college students' perceptions of technology acceptance based on the area of study and required task completion. In addition, numerous factors influence students' behavior and perceptions in relation to accepting technology in high school compared to elementary school and college. A deeper understanding of various motivating factors that affect technology acceptance in high school science may allow teachers to better understand their students' intentions to pursue biology based on students' beliefs and experiences in high school. In addition, a clearer understanding of technology acceptance in high school may provide insight into how science students perceive their learning and achievement in biology. Even though some researchers have explored technology acceptance based on the factors of outcome expectancy, task-technology fit, social influence, and self-efficacy in high school and college settings, these studies only explored each component separately or only two components together (Gao & Wu, 2015; George & Ogunniyi, 2016; Juhary, 2014; Jung, 2015; Manochehri & Sharif, 2010; Yang et al., 2015; Zamani & Shhoghlabad, 2012). In addition, while other researchers explored the technology acceptance of South African, Taiwanese, American, Indonesian, South Korean, and Malaysian students, no researchers have explored the technology acceptance of Hmong students (Alegria, 2014; George & Ogunniyi, 2016; Neo et al., 2015; Nugraini et al., 2013; Yang et al., 2015). Therefore, this proposed study explored all four components of technology acceptance in relation to Hmong high school students in biology or PLTW courses. This proposed study also expanded on current research about TAM, technology integration in the classroom, science technology, and PLTW by investigating the impact of technology innovations in high school biology courses on science learning for Hmong students. This study added understanding to the gap about the use and acceptance of technology in high school biology and to the learning of science for Hmong students.

Students' Perceptions of Technology Use

The integration of technology in the classroom may affect students' behavior and attitudes. In a multidimensional analysis study of high school students' knowledge of, attitudes toward, interests in, and importance about biotechnology, Fonseca et al. (2012) suggested that "students' perceptions are shaped by complex interactions between cognitive, motivational, and attitudinal elements" (p. 136). In a related study about students' attitudes and beliefs of information and communication technologies, Giannakos (2014) found that students' beliefs and attitudes are correlated with their performance, and their perceptions is correlated with what they have already learned and what they choose to do next. In an examination of how to engage students in secondary biology curriculum, Hagay and Baram-Tsabari (2012) found that students have been largely ignored in discussions about how best to teach science and that the curriculum is detached from their lives and interests. A number of studies have been devoted to student interests in science and pedagogy, but Hagay and Baram-Tsabari found little research focused on students' perceptions of technology use in science classrooms. Thus, drawing on students' perceptions of technology use provides means for investigating the impact of technology use on teaching science at the secondary level.

One impact of innovative technology in science classrooms is that students are encouraged to use models and probes. The use of models allows students to learn about STEM and STEM careers in biology, and the use of probes allow students to collect real time data and analyze and save their work (Staudt, Hanzlick-Burton, Williamson, & McIntyre, 2015). Based on past studies, the effectiveness of technology on the learning environment has had mixed results (Incantalupo et al., 2014). Research shows that students' perceptions about using technology as a learning tool are positive because students learn to take responsibility for their own learning and build lifelong learning skills (Khalil, Lazarowitz, & Hertz-Lazarowitz, 2014). On the other hand, other researchers who explored student perceptions of technology use have found different results. In this section, I first examined students' view of technology use based on quantitative and qualitative studies. I also examined students' views of technology use in biology, based on empirical research studies found in this review.

Students' Beliefs about Educational Technology Use in Science

For this proposed study, a review of research about students' beliefs about technology includes both educational technology and biology technology. This section focuses on students' beliefs about educational technology use, which includes computer software that presents information visually in terms of well-developed pictures, three-dimensional models, animations, and interactive environments, all of which are important for biology courses (Yapici, & Akbayin, 2012). Students' attitudes about computer technology are often positive because technology increases higher-order thinking, writing, and problem solving skills (Incantalupo et al., 2014). In a study of the impact of nanotechnology on students of different achievement levels, Lin and Lin (2016) found that 15-year-old students' interest and enjoyment in science determines their engagement in science, scientific competency, and scientific careers. The following section described quantitative and qualitative studies based on high school students' beliefs about educational technology use in science.

Quantitative studies. A number of quantitative empirical studies that are related to students' perception of educational technology use in science may help educators and researchers develop a deeper understanding of how students view technology innovations in high school biology courses. Students' beliefs about technology use are based on their learning effectiveness and attitudes toward the learning environment and the technology. In terms of learning effectiveness, Staudt et al. (2015) described a study that the National Science Foundation at the Concord Consortium conducted, which included 4,105 K-12 students and found that students who participated in the Innovative Technology in Science Inquiry project showed improvement in content learning and interest in STEM careers. Staudt et al. concluded that a connection between improved learning and positive experiences existed in the use of innovative technology in teaching science content. Students felt more engaged when using multiple digits to create DNA, and they explored transcription and translation using a Next-Generation Molecular Workbench model. Staudt et al. also reported that students were better able to explain their thought processes to the class and better able to use digital snapshots of their interactions with the models and online reports to evaluate their progress, they could elaborate on their own strategies of using the molecular models. In addition, Staudt et al. concluded that the outcome was positive because students expressed enjoyment about using probes and computers to help them, which they believed helped them to think about how studying STEM and science inquiry can affect their future.

Similarly, Nugraini et al. (2013) conducted a quasi-experimental study of 256 high school biology students in Indonesia in order to examine their use of technology in order to learn effectively. Nugraini et al. specifically examined the impact of e-Audio Visual (e-AV) biology on students' knowledge and interest in biology. A pre- and post-test was used to measure student attitudes, interest toward biology, and perceptions and perceived effectiveness toward biology in relation to this instructional media. The instrument was an author-designed test that had been pilot tested and improved based on students, teachers and research methodology experts' feedback "to measure the dimension of the experiment by the Biology Content expert, the educational and instructional media expert" (Nugraini et al., 2013, p. 381). The data related to student attitudes showed that students believed this instructional media significantly raised their motivation to learn and was more appealing to them. The data about student interest toward biology indicated that the use of instructional media and website technology improved students' interest toward biology. Nugraini et al. found a significant difference between the pre-test average of 3.33 and the post-test average of 4.23 on a five-point Likert Scale. In addition, students reported that they were interested in e-AV Biology because the animation with audio helped them in “class experiments to reach the standard biology marks of their teachers” (p. 381). The data about student attitudes and interest yielded positive perceptions and perceived effectiveness toward instructional media in biology. Thus, the use of media technology affected students’ perceptions toward the use of technology in biology courses. Nugraini et al. concluded that the perceived effectiveness of e-AV biology website was that it is useful for students to “improve their biology marks” and “influenced students to have positive interest in biology” (Nugraini et al., 2013, p. 385). Overall, the research of Staudt et al. (2015) and Nugraini et al. suggested improved learning in terms of student interest in STEM careers and biology content, and improved engagement, explanation of thought processes, motivation to learn, and enjoyment in using biology technology and educational technology.

Other studies have also yielded similar results regarding interest and improvement in science content learning. In a study using a pre-test-post-test titled *Equivalent Groups Design*, Suleman, Aslam, Sarwar, Shakir, and Hussain (2011) found educational technology in chemistry increases student interest in science and encourages students to be more attentive. Chemistry students reported that educational technology was helpful and effective in clarifying their understanding of scientific concepts (Suleman et al., 2011). Similarly, students believed that animation technology clarified their learning because the use of animated molecular processes was less likely to exhibit misconceptions when compared to still images in a book (Yarden & Yarden, 2011). Educational technology provided a better understanding of concepts and allowed students to score significantly higher in follow-up tests (Yarden & Yarden). As educational technology increases student interest and provides clarification of scientific concepts, it may be likely that an increase in student interest and science understanding may contribute to improved learning. In a related study, Yapici and Akbayin (2012) conducted an experimental study that included 107 biology high school students and found that the activities carried out with web-based applications yielded higher biology achievement than traditional teaching methods, and students' attitudes toward the use of the Internet for education, research, and information sharing was positive. Thus, these research studies support positive learning experiences related to the use of educational technology.

In relation to learning effectiveness, another study yielded positive outcomes in terms of learning and engagement. Using a pretest and a posttest, Lin and Lin (2016) evaluated the effects of comic book technology on Grade 10 science students and found that using online science comic books compared to science texts contributed to significant improvement in nanotechnology knowledge for students of various achievement levels. Lin and Lin found that students with different achievement levels have different perceptions about the learning effectiveness of reading online science comic books. The use of textbooks rather than computer generated comic books seems to be more beneficial for high achieving students than low achieving students while the use of comic books seems to be more beneficial for medium and low achieving students. Lin and Lin found that the use of textbooks is beneficial to high achieving students because students who read textbooks progressed significantly more than students who read comic books because "science texts transmit scientific information directly, but narratives in science comics transmit scientific information indirectly" (p. 1381). On the other hand, Lin and Lin found that the use of comic books is beneficial to medium and low achieving students because they made significant improvements in nanotechnology knowledge because they believed comic books made them feel that the "content with drawings is more interesting and easier to understand" (p. 1381). Although the use of comic books affects the learning effectiveness of all students, students' perceptions toward learning about nanotechnology were also affected by reading comic books. Lin and Lin used the *Public Emotional Perceptions of Learning Science* (PEPLS) questionnaire to "measure the effect of the learning intervention [comic book] on [students'] emotional perceptions of science learning" (p. 1379). Students perceived the reading of comic books to be a positive factor in learning about nanotechnology because 81.8% showed interest in the learning of nanotechnology with comic books. Students reported that the positive factors of comic books included features such as humor, narrative, and visual representation that attracted them to learn. Thus, the specific features of science comic books help students learn science and increase their engagement in learning science. Students' emotional perception of learning science is also slightly enhanced by reading comic books.

In terms of student attitudes, some quantitative research studies highlight how students perceive their interest and attitudes toward their learning environment that includes technology use. In a study related to biology and students' perceptions of the learning environment, academic achievement, and attitudes toward biology, Çakır and İskar (2015) found a positive and significant correlation between a technology-assisted learning environment and achievement and the attitudes of 402 biology high school students. Students' perceptions of the biology learning environment had a positive influence on their attitudes and achievement in biology as measured by nine of the scales of the *Technology Rich Outcomes Focused Learning Environment Inventory*, which correlated with the enjoyment of science lessons. Although a technology-enhanced interactive teaching environment contributes to positive student attitudes, it also contributes to improved student learning effectiveness, engaged participation in learning, reduced teacher lecture time, and increased student questions and talk response time (Yang et al., 2015). Thus, students' experiences with technological environments may generate positive perceptions toward the use of technology.

Students' perceptions toward the use of technology in an environment may include their beliefs and attitudes about the technology to help them learn science in that environment. Yang et al. (2015) applied an independent samples t-test to student scores on the *Constructivist Multimedia Learning Environment Survey* (CMLES) to investigate whether or not a significant difference exists in student attitudes toward an interactive white boards (IWB) integrated learning environment and the conventional ICT-integrated learning environment (Yang et al., 2015). The CMLES measures students' attitudes toward the process of learning with multimedia, and Yang et al. found that the use of IWB affected learning in biology courses. In this quasi-experimental study, which included 107 biology high school students, Yang et al. found that students have significantly more positive attitudes toward their learning environment when using IWB in a cell division lesson. Students using IWB had better scores than students not using IWB because the post hoc test showed that students in the IWB group had significantly better scores on all three sub-themes of chromosomes and their importance and meaning and the process of mitosis and its meaning and the process of meiosis. Yang et al. concluded that the higher score meant that students have "more positive attitudes toward the IWB learning environment" and considered the "IWB learning environment more interesting to use" (p. 272). Thus, students perceived IWBs to be an effective tool to stimulate and accelerate their learning and to strengthen their attention and learning motivation in biology courses. Without the use of technology, students often believe that their learning environment is limited.

Quantitative studies about student perceptions of technology use in science classes are also relevant. In a study that included 90 high school students in Florida, Barko and Sadler (2013) examined their use of an educational video game called Mission Biotech (MBt) in a virtual laboratory intended to provide a "context for using fundamental biological concepts and for introducing modern biotechnology tools and processes" (p. 29). In investigating the effects of MBt on students' attitudes toward science and science career, Barko and Sadler found that student attitudes toward science and careers in science did not support positive impacts of the gaming experience. Even though Barko and Sadler expected MBt to create excitement and interest toward science among students, their data did not support their expectation, because the posttest scores on the attitudinal instrument were lower than the pretest scores. Students expressed frustration with some of the game play, and they found the "game features tedious and grew frustrated when they could not skip ahead and get the answer" (Barko & Sadler, 2013, p. 32). In related research, Gao and Wu (2015) conducted an exploratory field study about the use of Moodle, and they found that students had a favorable attitude toward using Moodle as a learning technology. Students reported that the computer technology was a useful tool to help them stay on track with classwork and was convenient to use. The study results indicated that perceived irritation, perceived ease of use, and perceived relative advantage are significant predictors of students' attitude toward technology. Gao and Wu also found that both perceived ease of use and relative advantage have a significant positive correlation with technology acceptance while perceived irritation has a significant negative correlation with technology acceptance. In Barko and Sadler's study, student frustration with the use of the MBt technology supports perceived irritation while student satisfaction with the convenience of Moodle in Gu and Wu's study supports perceived ease of use. While frustration is linked to perceived irritation and convenience to perceived ease of use, the risk of trying new technology may support perceived relative advantage in explaining students' attitudes toward technology acceptance. In another study, Ngafeeson and Sun (2015) examined the role of technology innovativeness in determining students' acceptance of e-textbook. The findings of the study indicated that technology innovativeness has a direct positive impact on the willingness of students to try new technology and has an indirect influence on students' intentions to use e-textbooks. Although the availability of technology is a relative advantage, student intention to use technology may be positive or negative, depending on students' perceived usefulness of the technology. Thus, students' perceptions of the learning environment and of the use of technology in science classrooms are valuable in understanding their acceptance of technology.

Although Moodle and e-textbook positively impact student attitudes about technology, the use of other forms of technology, such as virtual field trips, web-based activity, e-library, and computer-generated comics, also make learning easier and more interesting for students. In a study about implementing technologies such as blogs, graphic websites, Prezi, and movie making technology tasks in the classroom to measure engagement, motivation, and satisfaction of students; Rafool et al. (2012) found that both elementary and high school students prefer using technology to learn. Rafool et al. reported that 79.2% of high school students in this study agreed or strongly agreed about the use of technology to increase their engagement in learning while 72.9% agreed or strongly agreed that they were more motivated when using technology. Overall, 75% of high school students were satisfied with technology-based learning. In a study of 211 secondary school science students, Puhek et al. (2013) found that students believed virtual field trips are suitable for the teaching of biology and were enthusiastic about the importance of virtual fieldwork. Similarly, Güngören et al. (2014) investigated how 100 tenth grade students used Meta-Analyzer and Web-Quest Library to solve problems and found six correlations among all of the TAM factors. The factors of satisfaction, ease of use, and usefulness were statistically significantly in relation to positive acceptance of web-based activities using the e-library. Students perceived the usefulness of Meta-Analyzer and Web-Quest Library and reported high intentions to use the online resources. In addition, students also perceived the usefulness of computer-generated comics in the teaching of science. In learning science, 81.8% of students reported that they were satisfied with using comic books to learn science, and 57.0% reported that they were satisfied with using text readers. Even though student use of science comic books did not affect achievement levels, students preferred science comic books over science text because they believed that science comic books allowed them to transform complex science words into simplified words to make science understandable (Lin & Lin, 2013). Overall, findings of these studies show that students learn better and have more positive experiences and attitudes when learning science when they use technology.

Other quantitative studies demonstrate a connection between students' positive attitudes toward technology and their motivation to use technology. Mueller et al., (2015) conducted a quasi-experimental study that included 85 high school science students in order to investigate the use of the Apple Genomics Project, a technology-enriched active learning experience. The Apple Genomics Project included seven computer modules and two lab activities of DNA extraction. Mueller et al. found that students using the Apple Genomics Project approach demonstrated similar motivation to learn science as students who did not use this approach. However, students who used the Apple Genomics Project had a more positive and engaging learning experience, and they found "learning biotechnology on the computer made the topic more interesting" (Mueller et al., 2015, p. 147). Thus, when students develop positive perceptions about technology, they may be more motivated to use the technology. Overall, quantitative studies suggest that learning effectiveness, attitude, and motivation contributes to positive students' perceptions of technology use. Students' views of technology use in biology are positive, based on their use of educational technology such as media, web-site technology and applications, IWB, e-AV, virtual field trips, e-library, computer-generated comics, and e-textbooks.

Qualitative studies. In addition to quantitative studies related to students' perceptions of educational technology use in science courses, relevant qualitative studies were also found in this review of the literature. Incantalupo et al. (2014) surveyed 885 students in Grades 9-12 to examine student attitudes and knowledge in technology-rich biology classrooms. They found that both male and female students perceived the technological learning environment positively, but male students perceived it more positively than female students. In a similar study, Lin and Lin (2016) surveyed and interviewed 720 tenth grade science students in Taiwan and found mixed student perceptions of using computer-generated comics to teach nanotechnology. Students' interest in reading science text through comic books was based on positive factors from the media and knowledge acquisition while students' lack of interest included dislike of science and nanotechnology and difficulty of understanding. Although both studies yielded mixed student perceptions about using technology, the presence of technology in the learning environment resulted in positive experiences for students. In other studies, factors such as mentorship, motivation, connection, and engagement support students' positive attitudes about technology use.

Although Lin and Lin (2016) and Incantalupo et al. (2014) found positive student perceptions about technology use, Preston et al. (2015) found that students' positive attitudes in using technology is due to reverse mentorship and student motivation. In terms of reverse mentorship, Preston et al. found that students bring technological experience into the classroom and believe that teachers need to utilize students' technological experiences. Students may feel valued when teachers seek them out to be part of the learning process by helping with technology troubleshooting. In terms of student motivation, the use of technology enhances the active learning and motivation of students. In a discussion of the benefits and challenges of technology in high schools, Preston et al. also found that technology engages students in their learning through virtual tours of Egypt and using the Smartboard to physically participate in building a molecule of DNA by pulling and dragging the components into the right place to actually build the molecule. In addition, Preston found that students expressed excitement about cell phone, iPads, Smartboards, and social media as technology could support and promote learning. Thus, students' perceptions of technology as supporting and improving their learning may lead to feeling more connected and engaged in their learning when they use technology.

In a mixed methods study, Childers and Jones (2015) explored 200 high school students' remote learning experiences in making connections with their learning and engaging in the use of the Remote Microscopy Lab via scanning the electron microscope. Students reported that they felt in control of the remote lab because they were able to make connection with remote scientists by asking questions and receiving quick responses to support their learning. In addition, students felt engaged with the sight, hearing, and touch features of the remote investigation. Students also reported that they were able to concentrate and interact with the scientists with a high level of realism. One student reported that the experience was realistic and it seemed that the bug was sitting on the computer and scientists were engaging in deep conversations with the student in real-time (Childers & Jones, 2015). Overall, these qualitative studies support positive student attitudes about using technology, which leads to positive learning experiences.

Students' Beliefs about Biology Technology Use

Similar to educational technology, limited research was found in this review related to students' beliefs about the use of technology in biology courses. This technology includes the use of computers combined with probewares such as Vernier LabQuest and Pasco AirLink that provide students with wireless connectivity to collect and monitor data in one location while streaming it to another location (Brunsell & Horejsi, 2013c). Researchers have noted that high school students need to experience effective technology education in biology because it is essential in developing their knowledge and science literacy (Mueller et al., 2015). Biology teachers have made efforts to integrate technology into biology curriculum, and they have recognized the importance of providing students with the basic principles and applications of biology techniques using technology (Miller, Sass, Wong, & Nienhuis, 2004). Although studies exist on biotechnology, these studies focus on students' perceptions of biotechnology content rather than the use of biology technology. Limited research was found in this review regarding high school students' beliefs about the use of biology technology. The following section includes a description of both quantitative studies and qualitative studies based on high school students' beliefs about technology use in biology.

Quantitative studies. Few quantitative studies were found related to students' beliefs about technology use in biology. Biotechnology is a topic requiring active hands-on learning and the use of tools and equipment such as micropipettes, thermal cyclers, centrifuge, vortex, trays, and gel boxes to study and manipulate DNA (Bigler & Hanegan, 2011). According to Peterman, Pan, Robertson, and Lee (2014), student experiences in biotechnology resulted in positive outcomes by engaging students in science and engineering practices. In a qualitative study that included 183 high school students, Peterman et al. administered a pre-post survey in the ScienceBridge program to measure student interest in the study, attitudes toward science, and awareness of and proficiency with biotechnology skills. Results indicated no change in student attitudes before and after the Tech Site participation. This finding demonstrated students' general attitudes about science and their overall skills in self-reported and academic outcomes, course grades, and exam scores (Peterman et al., 2014). Therefore, science attitudes may predict academic outcomes and serve as a constant for students' success in science courses. In another mixed methods study, Bigler and Hanegan (2011) administered a pre- and posttest to 93 high school students registered in biology classes about specific uses of biotechnology equipment and processes. The quantitative portion of this mixed method study included an analysis of student assessment data about DNA extraction and gel electrophoresis, polymerase chain reaction, DNA sequencing, bioinformatics, and phylogenetics. The results of the study focused on student perceptions and student achievement. The results indicated that students involved with biotechnology intervention gained more knowledge than students who did not use biotechnology intervention (Bigler & Hanegan, 2011). Thus, the use of technology in biology contributes to positive student perceptions in terms of engagement in science and gains in academic outcomes.

Qualitative studies. Limited qualitative studies on student beliefs about biology technology were also found in this review. However, both quantitative and qualitative research indicated positive student attitudes toward biology technology. Whereas quantitative studies indicated positive outcomes in terms of engagement and academic gains, qualitative studies indicated positive outcomes in terms of student interest, motivation, and preference and satisfaction related to biology technology.

A few researchers described students' beliefs about biology technology in terms of interest, motivation, and preference and satisfaction of the use of biology technology. A small number of published studies described biotechnology programs with positive results; the results indicate an increase in student interest in biotechnology programs and a positive shift in motivation to learn (Peterman et al., 2014). For example, in the qualitative portion of a mixed method study, Bigler and Hanegan (2011) analyzed student interviews to understand students' perceptions about a biotechnology program. Students reported that their gains in science knowledge through biotechnology intervention and hands-on learning provided them with opportunities for knowledge transfer to connect with their baseline knowledge. Students also reported that hands-on learning using biology technology made science come alive and deepened their knowledge about DNA because of the equipment they were able to use (Bigler & Hanegan, 2011). This deeper understanding encouraged students to explain why they did what they did to make learning meaningful. For example, students learned why they needed to add certain enzymes during each phase of an experiment, not just that they should add them. Students stated that they enjoyed the biotechnology lab because they actually completed the steps required for a protein chain reaction to occur rather than read about it or watch someone else do the steps (Bigler & Hanegan, 2011). In addition, students were fully engaged in DNA sequencing, and the data revealed that students who were interested in the intervention learned more. Students viewed the use of biology technology as beneficial because when "they are able to see what they are learning about and really interact with the subject material, the material becomes less abstract and students will begin to ask more open-ended questions allowing for deeper understanding" (Bigler & Hanegan, 2011, p. 248). Bigler and Hanegan concluded that the use of biology technology has an impact on student learning and also increases student interest and confidence in carrying out science experiments. Thus, similar to the use of educational technology, the use of biology technology generated positive attitudes and positive experiences for students.

Other qualitative studies also focused on students' beliefs about biology technology use. Spernjak, Puhek, and Sorgo (2010) conducted a study in which they examined 198 science students' opinions about using computer-supported laboratory exercises. In this study, computers were used as both a computer-supported laboratory and a virtual laboratory. The computerized laboratory used acquisition systems such as Vernier's interface, sensors and software to collect data and produce realistic graphs, and interactive simulations programmed in Microsoft Visual Basic 6.0. Sperniak et al. concluded that students preferred computerized experiments to classical laboratory and interactive simulations because "students found the greatest interest in computer supported real laboratory" (p. 26). Thus, results from this study indicate that students' interest in the use of biology technology may result in positive attitudes and experiences about learning science. Similarly, Santucci, Mini, Ferro, Martelli, and Trabalzini (2004) carried out a study with 318 high school students in Siena, Italy regarding innovative tools in science education, and they found positive student attitudes toward use of biology technology. Students used biology kits and lab equipment that the Bio-Rad Laboratories supplied. Students stated that the experience with the Bio-Rad tools was a positive component to their education. In addition, students were enthusiastic about working in a true laboratory to utilize the same techniques that researchers use. In a study with similar outcomes, Dong, Guerrero, and Moran (2008) explored an advanced placement biology class in Athens, Georgia in relation to the use of biology technology (e.g. micropipettors, microcentrifuge, water bath, and vortex) and also found positive experiences for students. Students reported that the laboratory that included biology technology helped them to understand modern DNA technology, DNA isolation, and PCR gel electrophoresis and how to use online databases. Dong et al. found that the use of biology technology opened students' eyes to a spectrum of new biological methods and provided them with a better understanding of how biology affects their environment. Students reported that they were inspired to think critically due to the laboratory exercises. Overall, students expressed satisfaction and positive reactions toward using innovative biology technology to learn about biology content.

Consideration of students' perceptions of technology provides an opportunity for students to express their interests about and their satisfaction with computer technology and biology technology. The use of student perceptual data ensures that student perceptions act as mediators in the learning process so students do not feel that the curriculum is detached from their lives and interests. These studies are important because they demonstrate that students believe computer technology is effective in biology education (Bigler & Hanegan, 2011; Dong et al., 2008; Peterman et al., 2014; Santucci et al., 2004; Spernjak et al., 2010). These positive results suggest that the use of computer technology is an effective teaching tool in secondary biology education. In addition, these studies indicate that the use of technology is effective in improving student achievement (Bigler & Hanegan; Santucci et al., 2004; Yapici & Akbayin, 2012). With the use of a blended learning model in a biology course, Yapici and Akbayin (2012) contended that "students' academic achievement levels and their attitudes are expected to develop" (p. 230). Thus, the use of technology in biology courses has the potential to improve the attitudes and achievement of students.

In summary, computers, other information technology, and biology technology influence how students perceive their science learning. The research studies found in this review indicated that the use of technology might increase student engagement, motivation, and satisfaction (Bigler & Hanegan, 2011; Dong et al., 2008; Peterman et al., 2014; Santucci et al., 2004; Spernjak et al., 2010). Studies also indicated that students accept, adopt and enjoyed using technology for learning in the science classroom (Bigler & Hanegan, 2011; Dong et al., 2008; Peterman et al., 2014; Santucci et al., 2004;

Spernjak et al., 2010). The attitudes of high school students toward computers as learning tools were mainly positive in this literature review. When used effectively, technology engages student in the learning process and involves students in actively using the technology to learn, construct, and understand. The effective use of technology can provide self-motivating and cooperative students with opportunities for fresh inquiry-based experiences and provide them with continuous real-time feedback that allows them to progress through traditional science content in nontraditional ways (Barko & Sadler, 2013). Both quantitative and qualitative researchers have assumed that when appropriate technological tools are used effectively and are integrated into the classroom, students will support a technologically-based curriculum (Kubiatko et al., 2011). Using new and innovative technologies may help bridge the gap between technology innovation and science learning for high school students. Thus, the understanding of student perceptions is important for revealing the beliefs and attitudes of high school science students about the use of biology technology. In this literature review, an abundance of research on quantitative studies about technology use was found, but limited research was found in relation to quantitative studies of biology technology use. Although a gap in the literature regarding students' perceptions of biology technology was found, a gap also exists in relation to research about the perception of minority students, particularly Hmong students, in using educational technology in science and in biology. Although student perception studies in biology technology are limited, no studies emerged on Hmong students' perceptions of technology use in biology. In addition, no studies emerged on Hmong students' perceptions of educational technology use in science. This gap is important because Hmong students generally do not perform as well in technology-rich biology courses, and therefore, a better understanding of Hmong students' beliefs and attitudes toward technology use in science and biology may help determine the reasons for their poor performance in these courses (Iannarelli, 2014; McCall & Vang, 2012). This proposed study would expand on current research by investigating the impact technology innovations in high school biology courses on science learning for Hmong students, using a qualitative approach. This proposed study addressed this gap by increasing understanding of technology acceptance from the perspective of Hmong students and their teachers.

Teachers' Perceptions of Technology Use

Studies of teacher behaviors in the classrooms have become the focus of many researchers in regard to computer technology use and biology technology use. In addition to teaching activities, students' learning accomplishments and attitudes toward science are connected to their perceptions of the learning environment and their teachers' perceptions of guiding their scientific learning (Kim, 2018; Yang et al., 2015). Using emerging and digital technologies to improve teaching and learning have been recognized by researchers, scholars, and teachers who believed that technology supports effective teaching in science (Owusu, 2015). Depending on the use of technology by teachers, technology can be a source or medium to transmit content or knowledge, and an interactive resource that positively affects teaching and learning (Incantalupo et al., 2014). In this section, I first examined teachers' beliefs about educational technology use based on findings from both quantitative and qualitative studies. I also examined teachers' perceptions of technology use in biology based on the research. Because the population of this study is an ethnic minority, the last section included an examination of research studies on teachers' beliefs about culture and its influence on learning.

Teachers' Beliefs about Educational Technology Use

Teachers' beliefs about of educational technology use vary from teacher to teacher and school to school. Studies have shown that teachers' attitudes toward educational technology influence their ability to successfully use technology with students (Moses, Wong, Bakar, & Mahmud, 2013). In addition, research has shown that teachers' beliefs influence educational technology use in their classrooms and that a positive view about technology use tend to allow teachers to use computers more in their lessons (George & Ogunniyi, 2016). Similarly, the amount of technology use and adaptation within a classroom is determined by teachers' motivation, knowledge, and technology skills (Ursavas, Sahin, & McIlroy, 2014). Some teachers refrain from making use of technology in their teaching. Although the integration of technology into teaching positively influences student learning, teacher acceptance of technology has been shown to have the greatest influence on the successful introduction of technology (Moses et al.; Ursava et al.). Students may be able to use technology for informal learning but without proper teacher support and acceptance, it may be unlikely for the technology to be fully integrated into formal learning (Mac Callum et al., 2014). My analysis of the following quantitative and qualitative studies focused on teachers' beliefs about the use of educational technology to improve student learning.

Quantitative studies. A review of the recent literature includes quantitative studies that measure teacher attitudes toward educational technology use because attitudes have been shown to have a major influence on technology use and acceptance. The literature review indicated teachers' attitudes regarding technology use is impacted by their beliefs about technology, their use of technology, and their beliefs about their competency or self-efficacy regarding technology. One aspect that impact teachers' adoption of technology is the beliefs that teachers hold (Mac Callum et al., 2014). For some teachers, anxiety plays a fear factor in resistance to new technology, and in one study, the thought of using ICT generated high levels of anxiety among teachers resulting to a perception that technology use may generate negative outcomes (Barbeite & Weiss, 2004; Buabeng-Andoh, 2012; Mac Callum et al., 2014;). Mac Callum et al. used a survey with a 7-point Likert scale to measure teachers' digital literacy, ICT anxiety, and ICT teaching self-efficacy. Mac Callum et al. used a structural equation modeling (SEM) to analyze the influence between digital literacy, anxiety, and teaching self-efficacy to perceived ease of use, perceived usefulness, and behavior intention. Results indicated that digital literacy, anxiety, and self-efficacy have a positive effect on teachers' intention to use mobile learning. Mac Callum et al. noted that teachers who see "mobile learning as a way to offer a substantial advantage to students' learning or their own teaching will adopt mobile learning" (p. 151). Teachers need to feel that they are comfortable with the technology, it is easy to use, and it is beneficial to support their teaching and students' learning. Teachers with an understanding of mobile literacy are better equipped to evaluate how valuable mobile learning supports their learning and teaching and provides them with confidence to use it. When teachers' experiences with the use of technology is positive, their beliefs about the use of technology may also be positive, and a direct relationship between teachers' behavioral intention to use technology and their perceived usefulness of technology may exist. Thus, teachers' beliefs about technology use in the classroom may be influenced by their beliefs, their perceived usefulness of technology, and their level of experience and ability to use technology to support student learning.

Another earlier study that Wu et al. (2008) conducted supports the notion that teachers who use technology develop more positive beliefs and attitudes toward technology-based instruction. In a study of 940 high school science and mathematics teachers in Taiwan, Wu et al. used a questionnaire to survey teachers' use of technology, and found a positive correlation between teacher's implementation of technology innovation and their attitudes and beliefs about educational technology. Wu et al. designed the questionnaire by selecting the items used in the instrument from existing questionnaires in order to measure attitudes and beliefs about technology-based learning and instruction, using a 5-point Likert scale. The Pearson correlation coefficient revealed positive correlations among practices, attitudes, and beliefs. The results of this study are similar to the results of the Mac Callum et al. (2014) study in that teachers believe that the technology is easy to use and beneficial to their teaching and to students' learning. Thus, teachers' implementation of technology innovation is related to their attitudes and beliefs about educational technology. Teachers who use educational technology tend to have positive attitudes toward technology use.

In other related research, Moses et al. (2013) surveyed 292 science teachers in Malaysia and found that perceived usefulness had a direct relationship with teachers' attitudes toward laptop use. Moses et al. reported that 43.8% of the variance in perceived usefulness was explained by perceived ease of use while 51.5% of the variance in attitude toward laptop use was explained by perceived usefulness. Thus, perceived usefulness was a predictor of perceived ease of use while perceived usefulness is a determinant of attitude toward laptop use. This finding implied that when teachers perceived laptops as easy to use, laptops might be perceived as being useful in their teaching. On the other hand, when teachers perceived that laptops were complicated to use, they also believed that laptops were less useful in their teaching. In this study, Moses et al. found that teachers were more likely to have a "positive attitude toward laptop use when they perceive laptop as useful in improving their teaching performance" (p. 298). Overall, the research of Mac Callum et al. (2014), Moses et al. (2013), and Wu et al. (2008) showed that teacher perceptions of technology is positive in relation to perceived usefulness and perceived ease of use. In connection to the proposed study, both perceived usefulness and perceived ease of use support the first and second components of the TAM model in which perceived usefulness contributes to outcome expectancy and perceived ease of use contributes to task-technology fit.

Another aspect that impacts teachers' adoption of technology is the actual use of technology by the teacher. Ward and Parr (2010) conducted a study that included199 secondary school teachers who responded to a survey regarding computer use and beliefs, and they found that teachers use computers mainly for professional work and personal use. In addition, Ward and Parr found that the primary motivating factor that influenced teachers' use of computers was their perception that positive student outcomes would be the result, despite potential barriers. Ward and Parr also found that limited teacher use of computer technology included factors such as quality of support and extent of barriers.

The perceived needs of students also influence teachers' perceptions of educational technology. In a different study, teachers viewed the use of multimedia as essential and important for students. Odcházelová (2015) surveyed 644 high school biology teachers about using multimedia in biology education and found that biology teachers accepted multimedia technology as useful teaching aides because they believed that multimedia use increased students' motivation, creativity, and activity and provided support for students with special needs. Thus, teachers' acceptance of technology plays an important role in their technology use and their students' technology use.

Another aspect that impacts teachers' adoption of technology is their beliefs about their competency or self-efficacy in using the technology. In a quantitative study of 288 secondary school science teachers, Puhek et al. (2013) hypothesized that teachers' attitudes about the usage of ICT included a positive attitude and actual use for work, a positive attitude but no actual use, and a negative attitude and no actual use for work. Puhek et al. found that teachers with excellent digital competence were more willing to use technology tools such as office tools, e-mail, the Internet, presentations, virtual laboratory, and data loggers than teachers with poor digital competence. On the other hand, Mac Callum et al. (2014) found that teachers' feelings of inadequacy may result in feelings of insecurity and a disinclination to use ICT, which may cause them to question the usefulness of ICT in teaching. Therefore, teachers' perception of their ability to use technology within the classroom plays a role in the adoption of technology and has a strong influence on ICT integration for teaching and learning practices. For example, Mac Callum et al. found that teachers with strong teaching self-efficacy for using ICT are more likely to use technology and less likely to be anxious or frightful of using it in the classroom. Mac Callum et al. surveyed 175 teachers and found that teacher self-efficacy in relation to the adoption of mobile learning impacted perceived ease of use, perceived usefulness, and intention to adopt. Mac Callum et al. found that teachers' ability to use technology with students was based on teachers' beliefs about technology, their digital literacy competency, anxiety, self-efficacy, actual use of technology, support in using technology, and the usefulness of technology on student learning and their instructional practice.

Qualitative studies. Studies were also found in this review of the literature that explored teacher attitudes toward educational technology use in a qualitative tradition. Although the methodology of qualitative research is different than quantitative research, the results were similar regarding teachers' perceptions of technology. The following qualitative studies indicated that teachers' beliefs about educational technology are based on perceived usefulness, their ability to use technology in their teaching, and the effectiveness of the technology. Teachers' perceptions of the use of educational technology might also be due to perceived usefulness.

In a case study of 10 high school science teachers, George and Ogunniyi (2016) asked them to complete a TAM-questionnaire to determine their behavioral intentions to make use of information communication technology (ICT) based on perceived usefulness, perceived ease of use, and perceived external control toward ICT. Teacher responses determined that the factor of perceived usefulness was most influential to teachers' intention to use ICT, and perceived external control was least influential to science teachers. These results support the idea that perceived ease of use could be an antecedent to perceived usefulness as users first adopt a technology based on task performance and level of operational difficulty. Thus, perceived usefulness influences science teachers' intention to use computers in science classrooms.

The use of technology may also depend on teachers' ability to effectively use the technology in their teaching. Owusu, Conner, and Astall (2015) analyzed 102 high school science teachers' responses to an online survey related to the seven constructs of the technological pedagogical content knowledge (TPACK) framework and found that teachers believed they were able to incorporate technology effectively in their teaching, and they reported positive perceptions about their ability to teach science. Although teachers scored high on the TPACK constructs, they did not have comparatively high technology knowledge. This finding may mean that teachers did not need to be expert technology users before incorporating technology in their teaching or they may have underestimated their technology knowledge and overestimated their TPACK.

Although teachers need to know how to effectively use the technology, the effectiveness of the technology also plays a role in teachers' acceptance of technology. Crippen, Archambault, and Kern (2013) surveyed 35 secondary science teachers about the nature of laboratory activities and the use of hands-on and simulated experiments, and coded the data using content analysis and found mixed results for the use of online activities. Crippen et al. found that online virtual science activities generated less student-teacher interaction, student engagement, and effectiveness of nonverbal communication but supported the "use of scientific discourse, student collaboration, analysis of error, and the ambiguity of empirical work" (p. 1043). In addition, they found that teachers believed that online virtual activities support science education by using technology tools for making sense of data, optimizing group composition, co-creating and sharing of artifacts, and accessing asynchronous and synchronous communication. In a different study, Yarden and Yarden (2013) investigated the challenges that 30 high school biotechnology science teachers faced in relation to using animation in class, and they found that teachers expressed positive attitudes toward animation use in class. Teachers found animation to be an effective tool when compared to other visualization tools. Teachers also expressed concerns about students watching animations. One concern that Yarden and Yarden noted was that "students might develop misconceptions due to the way molecules and chemical bonds are represented" because "the size of the DNA molecule and enzymes is not accurate from a biochemical perspective" (p. 694). Another challenge was that the complexity of the animation affects teachers' decisions about when to integrate animation into their teaching sequence. Despite these challenges, biotechnology teachers indicated that there are more advantages than disadvantages in using animation to teach biotechnological methods.

Teachers' Beliefs about Biology Technology Use

Technology in science teaching includes technology-enhanced Interactive whiteboards, learning management systems, and multimedia. The use of biology technology includes probe-wares such as Vernier LabQuest and Pasco AirLink, scientific lab equipment such as micropipetting and spectroradiometer, and computer simulation such as Apple Genomic Project and Catlab. When applying technology in biology, the teacher has to be convinced about its potential for improving student learning. Pertaining to science teaching, biology technology may help students understand abstract concepts such as invisible processes, energy, molecules, electrons, electric current, and chromosomes (George & Ogunniyi, 2016). The following quantitative and qualitative studies focus on teachers' perceptions of biology technology use.

Quantitative studies. Similar to students' beliefs about biology technology use, limited research was found in this review about teachers' beliefs about biology technology use. A few quantitative studies focused on this topic, but the use of technology did not occur in a high school setting (Forrer, Wyant, & Gordin, 2014; Kabakçı Yurdakul, Ursavaş, & Becit İşçitürk, 2014; Tao, Cheng, & Sun, 2012). Quantitative studies were found based on teachers' beliefs about technology use in science, but not about biology technology use (Cakir, 2011; Mac Callum et al., 2014; Moses et al., 2013; Mueller et al., 2015, Odcházelová, 2015; Puhek et al., 2013; Ward & Parr, 2010; Wu et al., 2008). Some qualitative studies were found based on teachers' beliefs about biology technology use, but limited quantitative studies of the same nature were found (Cakir, 2011; Childers & Jones, 2015; Ruggirello, Balcerzak, May, &

Blankenship, 2012; Tsai, 2015). In addition, some quantitative studies were found on teachers' beliefs about biotechnology content but not on the actual use of biology technology to study biotechnology (Huang, 2010; Machluf & Yarden, 2013). Thus, few quantitative studies focused on teachers' beliefs about biology technology.

In a quasi-experimental quantitative study related to teacher attitudes toward biology technology use in high school, Mueller et al. (2015) investigated the use of technology-enriched active learning experiences for eight science teachers in Indiana and found that the instructional activities contributed to four teacher perceptions that were useful in helping students learn biotechnology concepts. In terms of lesson content, teachers viewed the Apple Genomic Project technology as making the material relevant to students so they could relate to it and introducing the topic effectively to students. In terms of lesson activities, teachers indicated that students were engaged in the DNA extraction activity and talked about it for weeks. In addition, the activities were well received by teachers, and students enjoyed assimilating the information and sharing their results. In regard to the use of technology, teachers believed that full screen videos were helpful on specific biotechnology topics and the use of animation helped students understand biotechnology processes better. However, some materials may have been too difficult for students to learn from the computer without any assistance. Teachers believed the unit was of good quality, they received materials and resources for the topic, students were excited, and the information was valuable and well organized (Mueller et al., 2015). Overall, the teachers' impression of the technology-enriched unit was positive in terms of the use of biology technology.

Although limited quantitative research on biology technology was found in this review, other studies related to biology topics such as biotechnology indicated that teachers who integrate biotechnology into the high school curricula face major challenges. Teachers reported that topics like biotechnology, genomics, or genetics are the most challenging ones in the science curriculum for students (Mueller et al., 2015). Because PLTW involves biotechnology, the challenges of learning biotechnology may provide further insights into understanding students' perceptions of biology technology.

Qualitative studies. More qualitative studies that address teacher attitudes toward biology technology use were found than quantitative studies. In a study utilizing a semi-structured interview technique and classroom observations, Tsai (2015) examined a high school biology teacher's perspectives, influencing factors, and professional development regarding technology use. The teacher's perspective on technology use included technology as a tool for teaching and technology as a tool for learning activator (Tsai, 2015). The teacher believed that technology integration in biology is beneficial for presenting instructional material, providing concrete representations to change students' misconceptions, facilitating better understanding of abstract concepts by students, and motivating students to learn science (Tsai, 2015). Overall, the teacher exhibited an optimistic attitude toward technology use in biology.

In related research, Ruggirello et al. (2012) found that teachers also exhibited an optimistic attitude toward biology technology use. Ruggirello et al. observed and reflected on the performance of 90 high school science teachers in relation to an innovative technology lab in biology in which they used an economical spectroradiometer to measure the solar spectrum of photosynthetic light absorption. Teachers were also asked to modify the lab for use in their own high school classrooms. Teacher reflections on the potential to improve student learning through effective classroom implementation were positive. Ruggirello et al. reported that teachers rated the learning potential of the spectroradiometer at a 4.72 out of 5.00, and the ease of integration into the classroom at a 4.06 out of 5.00. Teachers believed that the importance of solar cell technologies and the topic were timely, the hands-on nature of the labs was excellent, and the lab had definite applications for use with students. Thus, the results of the Ruggirello et al. study are similar to the results of the Tsai (2015) study. Both studies support the notion that teachers develop positive attitudes toward biology technology and view biology technology positively in order to improve teaching and learning.

In a case study that employed the grounded theory data analysis technique of constant comparative method, Cakir (2011) found that science teachers reported positive perceptions of biology technology for improving science learning for students. Twelve prospective teachers enrolled in a teacher education program at a large university used a Catlab computer simulation to generate various characteristics in cats in order to explore the crossing of specific cats. The results of Cakir's study indicated that the Catlab supported prospective teachers' conceptual understanding of Mendelian inheritance. Prospective teachers who did not demonstrate deep conceptual understanding of Mendelian genetics were provided with enhanced instruction. Pre- and posttest data indicated an improvement from 39% on the pre-test to 67% on the post-test. Thus, the study suggested that science instruction enriched with the use of a computer simulation improved prospective teachers' conceptual understanding of Mendelian genetics. This improved understanding may lead to positive teacher perceptions about the use of biology technology.

Childers and Jones (2015) also conducted a study that demonstrated the value that teachers place on the use of biology technology. Childers and Jones interviewed three science teachers who taught biology using a web-based remote microscopy lab program and scanning electron microscope. All three teachers reported that they believed the remote microscopy session is valuable and "extremely important for all the students to be able to communicate with scientists" (Childers & Jones, 2015, p. 2446). Teachers believed that all science teachers should use technology that empowers students to communicate with scientists because they can answer questions and help students to consider content from the different perspectives of classmates, scientists, and teachers. In addition, teachers believed that the experience was real for students because students, the microscope, and the scientists were in a remote location rather than in the same location. The use of the remote microscopy lab and electron microscope indicated a disconnection between students and scientists because the experience was through the Internet rather than face-to-face. Thus, teachers believed that the use of biology technology was engaging and exciting for students.

Teachers' Beliefs about Influence of Culture on Learning

Although it is important to understand teachers' beliefs about educational technology and teachers' beliefs about biology technology, it is also important to understand teachers' beliefs about the influence of culture on student learning because the proposed study focuses on Hmong students in particular. Numerous researchers have identified various factors related to science learning that correlate to students' career decisions, science courses enrollment, and science teachers' influence, but they have failed to identify whether or not these factors correlate to race or ethnicity (Mutegi, 2013). It is unclear whether or not science teachers' beliefs about the influence of culture on student learning are connected to race or ethnicity. Teachers' beliefs may be based on the social construction of race, acceptance and respect for diversity, teacher-student relationships, and cultural connections.

An emphasis on the social construction of race may have resulted in beliefs that particular groups of students are not capable of pursuing science education and/or careers (Meyer & Crawford, 2015; Mutegi, 2013; Varelas, Kane, & Wylie, 2011). Students of color have often been portrayed as lacking knowledge, preparation, and achievement in science (Varelas et al., 2011). Some teachers reported that Latino and African American students face challenges in science because science is not culturally relevant with their backgrounds and they are not accustomed to the instructional settings (Meyer & Crawford, 2015). Furthermore, some teachers may construct an image of Black students and develop a perception that it is unrealistic for a Black student to consider work as a lawyer, doctor, or scientist (Mutegi, 2013). The social construction of race is an idea that is grounded in historical and social convention, and it plays an active role in shaping present day student-teacher interactions that merit consideration in studies of various racial or ethnic groups regarding science education (Mutegi, 2013, p. 88). Historically, African Americans were portrayed as physically gifted, lazy, happy-go-lucky, and mentally incapable sexual predators (Mutegi, 2013). This portrayal creates an image that African Americans are inferior when it comes to intelligence and academic learning. Another portrayal is that African American students are the most underperforming students among all racial and ethnic groups in relation to achievement in STEM (Varelas et al., 2011). Therefore, society's social construction of race may impact teachers' perceptions about teaching students from various racial or ethnic groups. Mutegi found that teachers' give advice not based on students' knowledge of the subject, but instead on the image of the students' descendants (p. 84). However, Mutegi also suggested that the social construction of race does not account for the identification of students in terms of competence in knowledge and understanding of science content. According to Carlone and Johnson (as cited in Mutegi, 2013) students should be identified for science career trajectory based on their ability to demonstrate their competence of science content and by their performance in science. Science education literature does not provide much insight into how career attainment in science for students of particular cultural groups might be racially or ethnically determined, but Mutegi contended that social and historical factors influence identity construction, which may influence students' attitudes toward science and their choice of science careers. Although the social construction of race has been found to influence the career attainment of African American students (Mutegi), what is not known is whether or not these findings apply to teachers of Hmong students and to Hmong students.

Although the social construction of race may account for the underrepresentation of African American students in science education, Mutegi (2013) contented that three dimensions of science identity may influence teachers' perceptions about the access of students of color to science education and science careers. These three dimensions include competence, performance, and recognition. Of the three dimensions, Mutegi contended that only recognition stands out as a key component of science identity development for women of color. Recognition fits the social construction of race for teachers advising students in science education because teachers' construction of race often influences the career attainment of students. According to Mutegi, a teacher's stereotype of African Americans is stronger than the teacher's informed image of African American students and shapes the teacher's guidance to them. In this situation, although the student may be a high achieving student, the teacher's perception of African Americans is given priority over their capabilities. Mutegi contended that teachers' perception of African Americans and the advice they provide may not reflect student knowledge and capabilities within a subject matter but instead is based on the construction of race. To further investigate the construction of race and the connection to teachers' perceptions of culture, Mutegi described an ethnographic study that was aimed at improving the identity construct in science education for 15 women of color. The disparity in educational achievement between various minority groups was well established because the data confirmed racial disparity among the 15 women. The study indicated that all women recognized themselves as scientists, but Native American and African American women exhibited a greater lack of recognition as scientists from science professionals than Caucasian and Asian women. Although science professionals invalidated some women while validating others, researchers did not identify racially disparate treatment as the cause of the disparate science career trajectories. Rather, the competence and performance of the students received recognition. The findings of this study did not explain why these dispositions are present in certain cultures. Therefore, it is not clear why Native American or African American women demonstrate lower confidence and interest in science. It may be that the social construction of race influences science teachers' beliefs about teaching them. Mutegi suggested that cultural and social factors of family background, community values, parental influence, cultural awareness, social support, cultural depravation, and cultural differences between students and schools may also influence science teachers' beliefs about teaching students of color.

Another factor that may influence teachers' perceptions of culture is considered in relation to accepting the culture of their students and respecting diversity. In a study about students' perceptions of their degree of similarity to their teachers, Gehlbach et al. (2016) found that an individual's perception of similarity to another person is a means to promoting a sense of relatedness and acceptance of each other. When teachers accept the culture of their students, that acceptance fosters positive social connections with students. Therefore, when teachers perceive themselves as similar to their students, they may leverage those similarities to improve relationships with students and their learning. Gehlbach et al. also found that differences in culture are not a barrier to learning because correlational studies indicate that similarities between people correspond with improved relationship outcomes. In other words, students who thrive in school typically cultivate positive relationships with teachers regardless of their culture. In relation to respecting students' diversity, Gehlbach et al. contended that teachers are motivated to perceive students whom they view as having similar values. In other words, the difference in ethnicity may not lead to similarity in skin color but leads to similarities in interests and values. Although teachers and students may be of different ethnicities, they still share similar values and are considered similar to one another. This similarity between teachers and students is based on Montoya and Myer's theory that interacting with similar people supports one's sense of self, one's values, and one's core identity (Gehlbach et al., 2016). Regardless of culture, as teachers interact with various students, they implement positive reinforcements in the classroom, based on their perceptions of shared values and beliefs. Gehlbach et al. suggested that finding differences in culture could result in finding other similarities that result in positive relationships between teachers and students. Therefore, a connection exists between social connection, shared interest, relationships, and motivation. Humans foster social connections with others as a fundamental and intrinsic social motivation (Gehlbach et al., 2016). The implication of Gehlbach et al.'s study is that when teachers understand their students' background, interests, personality traits, hobbies, attitudes, and identity, they develop positive teacher-student relationships, based on similarities that they have identified. Thus, when students learn that their values and beliefs are socially acceptable to their teachers, they may experience positive outcomes in the classroom ranging from happiness, desire to learn, liking, compliance, and student performance outcomes. Some teachers reported that students perform better academically when they belong to the same racial or ethnic group as their students (Gehlbach et al., 2016). By focusing the attention on what teachers and students have in common in terms of values and interest rather than the perceptions of how similar they are to one another in terms of race and ethnicity may lead to more positive relationships between teachers and students. Teachers may use these commonalities to understand the diversity and cultural differences of their students.

Improving real-world relationships between students and teachers is another factor that influences the impact of culture on teaching and learning. Researchers have shown that students who have established positive relationships with their teachers tend to achieve better in school than students with no bonds with their teachers and are more likely to disengage or be alienated from school (Gehlbach et al., 2016). Supportive teacher-student relationships are also associated with increased levels of student engagement in both cross-sectional analyses and longitudinal studies (Kelly & Zhang, 2016). In terms of relationships, trust and role modeling is an important factor in students' learning. Teachers who promote a sense of school membership, social connectedness, or identification with school also promote engagement in academic work (Kelly & Zhang, 2016). Other researchers found significant positive effects on test score outcomes for black teachers teaching black students and for white teachers teaching white students (Gehlbach et al., 2016). This outcome may suggest that black students trust black teachers, and white students trust white teachers. Students might be more likely to pay attention when they think their teacher cares more about them and where trust is not correlated with race. Studies of teacher-student relationships indicated that positive teacher and student relationships correspond with increased student participation, decreased disruptive behavior, and increased motivation and engagement (Gehlbach et al., 2016). For underserved Black and Latino students, receiving feedback about commonalities with their teachers allows them to understand that they are more similar than different to their teachers and to feel more positive about their relationships with their teachers (Gehlbach et al., 2016). Likewise, teachers who receive feedback about similarities with their underserved students feel more positive about their relationships with these students. When teachers learned about the similarities that they shared with their students, this similarity establishes a positive relationship that contributed to a reduction of the achievement gap by two-thirds or 0.2 of a letter grade (Gehlbach et al. 2016). This finding suggested that teachers who build relationships with students and understand their culture have a positive influence on learning. Similarly, when teachers value student ideas, treat student with respect and fairness, set expectations for success, and make efforts to understand student interests, positive sentiments toward the teacher result, and a feeling of belonging is created for students (Kelly & Zhang, 2016). Thus, relationship building between teachers and students should be directed toward supporting student learning regardless of race or ethnicity.

In order for teachers to better understand the culture of their students, they need to know about their culture. Cultural and linguistic diversity among students presents a challenge for teachers to create an inclusive learning experience for all students, ensuring that each student meets the rigors of the academic world while being culturally sensitive to all learners (Lopes-Murphy & Murphy, 2016). A better understanding of students' culture may lead to a better understanding of how to improve instruction and utilize resources to meet students' learning needs. One approach to being culturally sensitive is to use a multicultural inquiry approach that involves underrepresented students in scientific activities while providing them with structured language support and instructions (Meyer & Crawford, 2015). The use of a multicultural inquiry instructional approach may reshape student self-efficacy in science while fostering a learning environment that allows students to investigate actual science practices and provides opportunities for mediating between student, school, and culture (Meyer & Crawford, 2015). A teacher in Meyer and Crawford's study stated that it is important to create cultural bridges to help students access science when drawing on their cultural knowledge. It is the teacher's role to bridge students' views of science to scientists' views of science in order to leverage scientific learning (Meyer & Crawford, 2015). Thus, inquiry approaches that provide diverse students with opportunities to experience authentic science and that draws on their everyday knowledge, culture, and linguistic resources can provide them with an improved understanding about science and science learning.

To better understand cultural diversity, research shows that teachers who support the cultural aspects of students are able to better accommodate their learning (Bang & Baker, 2013). In Korea, female students have fewer science-related experiences and activities, lower participation in science clubs, and lower science-related career paths than male students (Bang & Baker, 2013). This finding suggests that female students in Korea experienced significant disadvantages in science education compared to male students. However, Bang and Baker also found that school administrators and science teachers hold stereotypical perceptions regarding the ability of female students to learn science, and this perception contributed to fewer scientific achievements and negative attitudes toward science for these female students. Teachers also believed that female students are not good at science, showed little or no confidence in their ability to understand science inquiry, are not interested in scientific subjects, and perceive science as difficult (Bang & Baker, 2013). The stereotypical perceptions regarding female science students may contribute to their under-performance in science. To empower female students, teachers who work with Korean students will need to spend additional time with female students so male and female students can learn equally. By understanding this gender gap in the Korean culture, teachers could provide more opportunities for female students to be involved with science in order to develop positive attitudes toward science and to improve their recognition in science so they are motivated to achieve success. Teachers need to understand that when female students are interested in the educational tool (interactive whiteboards, Easiteach software, Google, gmail, photostory, digital video library, and podcast software), learning performance in science improves (Incantalupo et al., 2014). Thus, understanding gender differences among cultures helps teachers to better understand cultural diversity and to provide accommodations for students that improve student learning in science.

Cultural connections also influence student learning in science. The challenges students with diverse cultures face included disconnection between their own cultural knowledge and science disciplines, and primary discourse at home, community, and school (McCollough & Ramirez, 2012). Similarly, the challenges teachers face included consideration of students' linguistic and cultural experiences, and high academic standards. In a study about using family science learning events to design culturally relevant science activities for K-8 students, McCollough and Ramirez found a difference between Anglo middle class culture and values, and non-Eurocentric culture and values. Students of the Anglo middle class culture are often perceived as academically and socially superior compared to non-Eurocentric students. Despite the best intentions of teachers to teach to diverse students, McCollough and Ramirez concluded that many Hispanic students are failing in American schools due to resistance of the middle class culture and the upholding of their own culture. In addition, Hispanic students recognize that the knowledge they bring to school is devalued by the Anglo culture and value. Therefore, the diversity of student backgrounds serves as an important reminder for teachers to develop an understanding of their students' lived experiences and to increase teachers' awareness of the value that colored students bring to the classroom. The studies of Bang and Baker (2013) and McCollough and Ramirez highlighted not only for the need for teachers' to be culturally aware but to value cultures different from their own in order to create an inclusive science pedagogy that invites positive learning experiences for students of color. According to McCollough and Ramirez, an inclusive education is possible only by valuing the students' home culture and personal experiences as racially classed and gendered people. In addition, cultural inquiry and research-based science content knowledge should be accessible to all students. In supporting culture and science learning, McCollough and Ramirez contended that an inclusive education can help teachers develop a culturally relevant pedagogy where students develop and maintain cultural competence, are conscientious to challenge the status quo, and experience success in science. In addition, teachers' exploration of students' cultural perspectives and racial and ethnic identities different than their own minimizes disconnection and construction of race. The disconnection of students' cultural knowledge and science disciplines and the connections between home, school, and community may be minimized by implementing explicit programs that emphasize parent education, multicultural education, and teacher education. Thus, teachers can better support science learning by understanding the culture of their students.

In summary, this section of the literature review included an analysis of research related to teachers' perceptions of educational technology use, biology technology use, and the influence of culture on learning. The research shows that teacher beliefs and attitudes toward technology use have a direct effect on teachers' intention to use technology (Moses et al., 2013; Mueller et al., 2015). The literature also suggests that teachers' perceived beliefs and attitudes toward technology are factors affecting their use of technology for teaching. Numerous researchers have also hypothesized that perceived ease of use and perceived usefulness are the predictors of teachers' attitude toward technology use (Gehlbach et al., 2016; Mac Callum et al., 2014; Moses et al., 2013; Mueller et al., 2015; Odcházelová, 2015; Wu et al., 2008). Moses et al. (2013) suggested that PEU and PU predicts teachers' attitude toward laptop use in science and mathematics. Because attitude serves a key role in determining the use and acceptance of technology, it is important to further explore the antecedents of teacher beliefs and attitude toward educational technology and biology technology. The literature review is connected to the proposed study because science teachers' beliefs may affect their attitudes, and their attitudes may affect their intention to incorporate technology-aided instructional tools in the classroom (Yarden & Yarden, 2011, p. 691). The literature review is also connected to the proposed study because TAM is used as a framework. Despite several studies that were found about the use of TAM, studies on teacher acceptance of classroom technologies are limited (Ursavas et al., 2014). More specifically to this study, research on teachers' beliefs about biology technology use is limited. It is important to understand both teachers' beliefs about educational technology use and teachers' beliefs about biology technology use in biology classrooms in exploring the impact of technology innovation on science learning for Hmong students. In addition, the understanding of teachers' beliefs about educational technology use and biology technology use will expand on current research of teachers' perceptions of student technology use. Another purpose is to add to existing literatures by supporting theoretical and empirical approaches that explain Hmong students' science teaching and learning. A more explicit understanding of science teachers' beliefs about the impact of the Hmong culture on the science learning of these students may help teachers develop stronger relationships with these students. This understanding may also provide teachers with culturally relevant pedagogy that improves students' motivation, interest, and confidence in learning science and in using educational and biology technology.

Summary and Conclusions

In summary, this chapter included a review of the research literature in relation to Hmong learners, technology acceptance in high school science, high school students' perceptions of technology use, and teachers' perceptions. This chapter also included a description of the specific search strategies used to conduct the literature review and the conceptual framework of the TAM, which is based on Gu et al.'s (2013) four constructs of outcome expectancy, task-technology fit, social influence, and personal factors. In relation to the literature review, researchers found that outcome expectancy in the form of performance, intention to use and reuse, perceived ease of use, perceived usefulness, and satisfaction are likely the reasons affecting students' acceptance of technology (El-Gayer et al., 2011; Li et al., 2012; Nistor et al., 2014; Van De Bogart & Wichadee, 2015). Researchers also suggested that TTF is intrinsically related to outcome expectancy and directly affect intention to use technology (El-Gayer et al., 2013; Shih & Chen, 2013). Similarly, social influence has a significant and positive effect on the adoption and use of technology (Chen, Lin, Yeh & Lou, 2013; El-Gayer et al., 2013; Qin et al., 2011). In addition, personal factors such as self-efficacy, learning style, and culture affect technology acceptance (Al-Azawei & Lungvist, 2015; Li et al., 2012; Sadeghi et al., 2014). Thus, the literature review supports Gu et al.'s (2013) conceptual framework regarding the effect of outcome expectancy, TTF, social influence, and personal factors on technology acceptance.

Other than Gu et al.'s (2013) four TAM constructs, the literature review also provided insights into Hmong students, and both technology and biology technology acceptance for students and teacher. Current research on Hmong learners emphasizes how the history of the Hmong people has resulted in cultural and linguistic challenges that they face in learning science and technology. Historically, Hmong students learned information orally from their elders and by observation (Yang, 2012). Current researchers have also found that Hmong students are often asked to learn information through analogies and relationships in school represented by higher levels of abstraction (Mahowald & Loughnane, 2016). It is not known if a transition from an oral method of learning to an abstract method of learning impacts Hmong students' ability to learn science. However, it is known that school systems are not well equipped to deal with changing cultural dynamics, and therefore, culture may play a role with Hmong students' learning of science and technology (Carpenter-Aeby et al., 2014b). Further exploration of Hmong culture and science learning indicated that cultural values such as family cohesiveness and interdependence play a critical role in Hmong students' acquisition of life skills through direct teaching from family members (McCall & Vang, 2012; Yang, 2012). In addition, Hmong students face difficulty learning and understanding a scientific concept that is not present in their everyday lives (Cobb, 2010; Dung et al., 2012; Xiong & Lee, 2011). Researchers agree that Hmong students have unique cultural, social, and personal influences and experiences that influence both their science achievement and educational achievement (Carpenter-Aeby et al., 2014a; Carpenter-Aeby et al., 2014b; Iannarelli, 2014; Vang, 2013). Thus, Hmong students' culture and language, perception of learning science, unique social influences, and unique personal factors might limit their access to standard instructional practices, science learning, and use of technology in the United States.

Several themes emerged from a review of the literature. The first theme is that students' acceptance of technology depends on outcome expectancy, TTF, social influence, and personal factors. Students will accept the technology based on outcome expectancy if they perceived the technology to be useful and based on TTF if they can use it (Puhek et al., 2013; Thompson, 2012; Yusoff et al., 2011). Numerous researchers who explored outcome expectancy indicated that attitude and intention significantly influence technology acceptance (Horzum et al., 2014; Lawanto et al., 2012; Puhek et al., 2013). Researchers who explored TTF indicated that technology has a positive impact on student acceptance if the technology meets the task requirements students are being asked to do and is easy to use (Brunsell & Horejsi, 2013a; Gao & Wu, 2015; Lawanto et al., 2012). Researchers who examined the social influence of technology acceptance found that both instructors and peers play a vital role in students' acceptance of technology (Courtois et al., 2014; Nathan et al., 2013; Svendsen et al., 2013). Researchers who explored personal factors found that self-motivation, direct guidance, confidence, self-efficacy, and positive attitude leads to higher expectations toward technology acceptance (Al-Azawei & Lundqvist, 2015; Courtois et al., 2014; Lawanto et al., 2012; Lin & Lin, 2016). Thus, outcome expectancy, TTF, social influence, and personal factors played a significant role in technology acceptance.

A second theme is that the investigation of Hmong learners and TAM led to positive understanding of students' perception of technology use. Although the literature review included studies about technology acceptance in high school, it also included studies about high school students' perceptions of technology use. Students' perceptions of technology use are shaped by cognitive, motivational and attitudinal elements (Fonseca et al., 2012; Giannakos, 2014). Researchers found students' perceptions of the impact of educational and biology technologies on their learning were both positive and negative. Both qualitative and quantitative studies on students' views of technology use indicated students' attitudes are positive based on their beliefs about its learning effectiveness and based on their attitudes toward the learning environment. Students perceived technology as a tool to improve higher-order thinking, content acquisition, academic performance, writing, problem solving, interest and enjoyment in science, motivation to learn, connections to science, and explanation of thought processes (Incantalupo et al., 2014; Lin & Lin, 2016; Nugraini et al., 2013; Preston et al., 2015; Staudt et al., 2015; Suleman et al., 2011; Yarden & Yarden, 2011). Similar to students' views of biology technology use, studies on students' views of biology technology use also yielded positive student perceptions. Some of these similar student perceptions, such as engagement in science practices, academic gains, motivation, confidence, and interest, were present in biology technology use and in educational technology use (Bigler & Hanegan, 2011; Peterman et al., 2014; Spernjak et al., 2010; Yapici & Akbayin, 2012). Thus, students viewed the use of both educational and biology technology positively.

Another theme that emerged from the literature review was that positive teachers' perceptions toward educational and biology technology use also existed. Current research on teachers' views of technology use indicated that teachers' attitudes regarding technology use is impacted by their beliefs, use of technology, and beliefs about their competency or self-efficacy (Mac Callum et al., 2014; Moses et al., 2013; Odcházelová, 2015; Puhek et al., 2013; Ward & Parr, 2010). Teachers' perceptions of their ability to use technology within the classroom play a role in the adoption of technology for teaching and influences the integration of ICT into their teaching practice. In addition, researchers found that the perceived usefulness of technology influenced science teachers' intentions to use technology in the science classroom (Childers & Jones, 2015; Mac Callum et al., 2014; Tsai, 2015; Ward & Parr, 2010). Similar to studies of teachers' views of technology use, the limited studies on teachers' views of biology technology use yielded positive perceptions. Current research on teachers' views of biology technology suggested that teachers developed positive attitudes for biology technology and viewed biology technology positively to engage, excite, improve, and activate teaching and learning (Cakir, 2011; Childers & Jones, 2015; Ruggirello et al., 2012; Tsai, 2015). Thus, similar to students, teachers exhibited an optimistic attitude toward both educational technology and biology technology in biology classrooms.

Although the literature review generated relevant research regarding Hmong learners, technology use and acceptance, and perceptions of both educational technology and biology technology, it also revealed a number of gaps. First, little is known of Hmong students' perceptions of learning science in biology settings. Although the Hmong's history, livelihoods, and culture has contributed to limited science and technology learning, there is little research related to how the Hmong use, accept, and perceive biological science and technology use (Dung et al., 2012; Luong & Nieke, 2013). Therefore, the learning style of Hmong students is a gap that requires further investigation. In addition, although research exists regarding technology acceptance, there is limited research regarding technology acceptance in high school biology. In relation to the four TAM constructs, there is a scarcity of studies pertaining to TTF in high school students and in high school biology. Although some studies on technology use in high school biology were found (Cheung et al., 2011; Courtois et al., 2014; Giannakos, 2014; Thompson, 2012), no TTF studies on biology technology in PLTW courses were noted. Similarly, there are limited studies on social influence in high school biology and PLTW courses. In addition, gaps in the research emerged regarding the social influence and personal factors of Hmong learners that may contribute to technology use.

A review of the research literature also revealed little research focused on students' perceptions of technology use in science classroom (Hagay & Baram-Tsabari, 2012). Although there were limited quantitative and qualitative studies regarding biology technology, few studies relating to students' view toward biology technology use were found. Comparable to students' view of biology technology use, limited research on teachers' view of biology technology use exists. Thus, a significant gap is a lack of research on the impact of technology innovations in high school biology courses on science learning for Hmong students. Based on the literature review, this study addressed this gap in the literature and extended knowledge in the science discipline. This case study contributed to the research on Hmong students and technology use and acceptance by examining Hmong students' perception and teachers' perception for teaching strategies or learning style that will support, develop, and sustain the educational achievement of all Hmong students regardless of culture, language, social influences, and personal factors. This proposed study explored all four components of TAM together and focus mainly on Hmong high school students in biology or PLTW courses. This proposed study expanded on current research of TAM, technology integration in the classroom, science technology, and PLTW by investigating the impact of technology innovations in high school biology courses on science learning for Hmong students. In addition, this study advanced understanding about the use and acceptance of technology in high school biology and about the learning of science for Hmong students.

Chapter 3: Research Method

The purpose of this qualitative case study was to describe how technology innovations in high school biology courses impact science learning for Hmong students, based on a TAM. To accomplish this purpose, I described the conceptual framework of the TAM that includes the constructs of outcome expectancy, TTF, social influence, and personal factors (Gu et al., 2013) to understand how Hmong students view their learning of science using technology and how their science teachers view their learning and technology use. I also described how Hmong students and their science teachers perceive the usefulness and ease-of-use of technology innovations in high school biology courses. I also described documents related to this innovative biology course.

This chapter is about the research method used to conduct this study. It includes a description of the research design and rationale, the role of the researcher, participant selection, instrumentation, and procedures for recruitment, participation, and data collection. In addition, this chapter includes a description of the data analysis plan and a discussion of evidence of trustworthiness and ethical procedures. This chapter ends with a summary of the research design.

Research Design and Rationale

The following central research question for this study is related to the conceptual framework and the literature review: How do technology innovations in high school biology courses impact science learning for Hmong students based on a technology acceptance model? The related research questions include the following:

1. How do Hmong students perceive the usefulness and ease-of-use of technology innovations in high school biology courses?
2. How do high school biology teachers perceive the usefulness and ease-of-use of technology innovations for Hmong students in their courses?
3. What do course documents reveal about how technology innovations are integrated into high school biology courses?

A single case study design was selected for this case study. Yin (2014) defined case study using a twofold definition. In the first part of the definition, Yin (2014) defined the scope of a case study as "an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident" (p. 16). In the second part of the definition, Yin (2014) contended that a case study is an inquiry that has "more variables of interest than data points; relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result; and benefits from the prior development of theoretical propositions to guide data collection and analysis" (p. 17). This twofold definition of case study distinguishes case studies from other qualitative designs because a case study is unique in that it depends on the analysis of multiple data points to provide thick description, explain causal links in real-world interventions, and illustrate topics in a descriptive mode to enlighten situations that has no clear or single outcome.

Researchers who use a case study design want to understand a real-world phenomenon, and they assume that such an understanding is likely to involve important contextual conditions pertinent to the case under investigation (Yin, 2014). My use of a case study research design is appropriate for this study because a case study contributes to advancing knowledge of individuals; therefore, this design allowed me to focus on individual science teachers and Hmong students. In addition, the focus of a case study is often to describe or explore a holistic and real-world perspective of small group behavior, and my purpose was to describe how a small group of Hmong students use technology to learn science. Furthermore, according to Yin (2014), questions involving "how" and "why" are explanatory and lead to the selection of a case study research design. In this situation, a case study is appropriate for this study because I wanted to understand why Hmong students struggle to learn science and how the use of technology in an innovative biology course impacts their science learning. Research indicates that Hmong students have learning challenges related to science and technology, and they lag behind other ethnic groups in science performance (Carpenter-Aeby et al., 2014a; Lor, 2013; Luong & Nieke, 2013; Mahowald & Loughnane, 2016; Yang, 2012). Thus, a case study design allowed me to investigate a complex phenomenon such as the impact of technology innovations that teachers use in a high school biology course on science learning for Hmong students. This phenomenon involves many variables, including student and teacher beliefs about educational technology and biology technology use. In addition, the unique features of a case study research design allowed me to rely on multiple sources of data to explore this phenomenon, including individual student interviews, individual teacher interviews, online reflective journals to answer my research questions, and course documents.

Other qualitative designs, including phenomenology, grounded theory, and ethnography, were considered for this study based on the cultural group of the research participants, but were rejected. A phenomenological study could have been appropriate for this study because the goal of this research design is to describe the "common meaning for several individuals of their lived experiences of a concept or a phenomenon" such as Hmong students' experiences related to technology innovation in science courses (Creswell, 2013, p. 76). Although this design had possibilities for this study, it was rejected because the focus was on the impact of an innovative biology course on the science learning of Hmong students. Grounded theory may also have been an appropriate design for this study because the intent of this design is to move beyond description to generate or discover a theory to explain a process or an action (Creswell, 2013). Although it may be relevant to generate a theory about how Hmong students learn science with the use of technology, the purpose of this study was not to develop a theory but to develop a deeper understanding of how technology innovations in high school biology courses impact science learning for Hmong students based on a TAM. In addition, data collection for a grounded theory research design requires numerous lengthy interviews, which was not feasible for this study based on location and time. Similarly, the qualitative design of ethnography could have been an appropriate design for this study because it involves studying a particular group or culture over a prolonged period of time in the field. However, this design was rejected because it conflicted with my limited time and resources as a single researcher.

Role of the Researcher

The researcher is the primary instrument for data collection and analysis (Merriam, 2009). For this study, I served as the primary investigator. I was responsible for all data collection, data analysis, and data interpretation. In addition, I was responsible for selecting the research design, choosing the participants, determining the data sources, creating the data collection instruments, and developing the procedures for recruitment, participation, and data collection. In addition, I was responsible for all data analysis and for using strategies that improve the trustworthiness of this qualitative research and minimize potential for researcher bias. I addressed these biases by implementing specific strategies to enhance the trustworthiness of this study, including triangulation, member checks, and reflexivity, which were described later in this chapter.

My current position as a school administrator with the title of associate principal did not conflict with my role as a researcher. The school district where I am currently employed is not the school district that includes the research site for this study. I am not employed as an administrator at either of the two sites and do not have any supervisory responsibilities for participants, both teachers and students. Although I worked for 6 years at the research site as a biology teacher and have a collegial relationship with those science teachers, my past employment did not conflict with my role as a researcher because I did not have any supervisory responsibilities over potential participants.

Participant Selection

The participants for this study included eight high school biology students and two high school biology teachers in a public-school district in the Midwestern region of the United States. Participants were selected from a public high school of the district. Participants at the high school included eight students per course for a total of four students and two teachers.

Participants were selected according to specific inclusion criteria. Teachers needed to meet the following inclusion criteria: (a) must be employed as a full-time biology teacher at one of the research sites with a valid state certification, (b) must have obtained PLTW certification as a result of district training, and (c) must have taught an innovative biology course such as principles of biomedical science, human body systems, medical interventions, or biomedical innovation for at least 1 year with master teacher status. Students needed to meet the following inclusion criteria: (a) must be of the Hmong ethnicity group, (b) must be full-time students at one of the research sites, and (c) must be enrolled in at least one of the innovative biology courses such as principles of biomedical science, human body systems, medical interventions, or biomedical innovation. The information required for both the teacher and student inclusion criteria were obtained from the principal and teachers. For teachers, the principal verified valid state certification, and certification were confirmed on the state department of education license website. Teachers also provided a copy of their PLTW certificate as proof of training. In addition, the principal also provided a copy of the teachers' course assignments for the last 2 years as confirmation of teaching an innovative biology course. For students, the principal provided an enrollment transcript with relevant information regarding ethnicity and course selections. For the protection of participants, the names of teachers and students were omitted from all inclusion criteria information obtained from the principals and teachers.

In relation to inclusion criteria for student participants, my research study included only students from the Hmong ethnic group. Although I understand that technology innovation in innovative biology courses impacts all students regardless of ethnicity, my rationale for excluding other ethnic groups includes (a) limited research on how Hmong students use technology to learn science and (b) research on other minority groups about learning science.

In terms of limited research, the use of technology in biology is underrepresented among ethnic groups and minorities (Hoard, 2015; Iannarelli, 2014; McCall & Vang, 2012). Some researchers have found that science is a challenging subject for Hmong students to learn (Huffcutt, 2010; Vang, 2013; Xiong & Lam, 2013), and teachers are challenged to effectively teach science content to Hmong students (Ricketts, 2011). Research has been found in relation to minority students' use of science technology, students' perceptions of the learning material, and the impact of technology on their learning (Ercan, 2014; Johnson & Galy, 2013; Oliveira et al., 2014; Osman & Vebrianto, 2013), but not on Hmong students. Some research has been found on Hmong students in terms of home environment, cultural values, and technology use (Carpenter-Aeby et al., 2014a; Cobb, 2010; Dung et al., 2012; Her, 2014; Iannarelli, 2014; Lee & Green, 2010; Lor, 2013; Mahowald & Loughnane, 2016; Mao & Xiong, 2012; McCall & Vang, 2012; Supple et al., 2010; Upadhyay, 2009; Xiong & Lee, 2011), but not on the impact of innovative technology on biology learning for Hmong students.

Research studies on other minority groups have also been conducted. Studies have been found on Latino American students in terms of their cultural values and educational experiences and the use of e-learning tools to improve their academic performance (Johnson & Galy, 2013; Kelsey, Mata-Claflin, Holland, & Castillo, 2011; McCollough & Ramirez, 2012). Other studies have been focused on an analysis of the science vocabulary of Latino American students and their opportunities to participate in science inquiry (Helman, Calhoon, & Kern, 2015; Sprague Martinez, Bowers, Reich, Ndulue, Le, & Peréa, 2016). Studies have also been conducted regarding the perceptions of African American youth about health science and about their participation in high school STEM activities (Boekeloo, Randolph, Timmons-Brown, & Wang, 2014; Hoard, 2015; Sprague Martinez et al., 2016). In relation to Asian Americans, researchers examined the concentration of Asian Americans in the STEM and health-care fields of study and their likelihood to choose STEM careers based on their confidence level of math and science abilities (Min & Jang, 2015; Moakler & Kim, 2014). In addition, studies on Asian Americans focused on the misrepresentations of Asian Americans in the curricula and Asian American youth's perspectives on cultural awareness, belonging, engagement, and empowerment (Endo, 2012; Tokunaga, 2016; Wexler & Pyle, 2012). Although there is research on minorities, the studies were not focused on the Hmong ethnic minority.

Instrumentation

For this study, I designed three instruments, including the interview guides, the reflective journal, and the document data collection form. I also established an expert panel to help me determine the trustworthiness of these qualitative instruments. The expert panel was comprised of two colleagues with doctorate degrees in education, and their goal was to review these instruments for alignment with the central and related research questions for this study. Panel members reported that the interview guides, reflective journals, and observation data collection form were aligned with the research questions.

Interview Guides

According to Patton (2002), the "purpose of interviewing is to allow us to enter into the other person's perspective" in order to make explicit their feelings, thoughts, intentions, and stories (p. 341). To capture both student and teacher perspectives about the use of innovative technology in biology courses, interview questions must be designed that are purposeful and meaningful. The interview guides for this study are based on research that Merriam (2009) presented in relation to conducting effective interviews for qualitative research. The interview guides were structured because Merriam indicated that a structured interview is guided by a set of open-ended questions that are prepared in advance and have a predetermined order. In preparing the questions, Merriam noted that the key to getting rich data is to ask questions in clear, understandable, and familiar language and to avoid technical jargon or terms. According to Merriam, good questions are those that are open-ended and yield detailed and descriptive data. In addition, Merriam recommended using "why" questions as these "questions can uncover insights that might be speculative but might also suggest a new line of questioning" (p. 97). The use of "what" and "how" questions provided experience of what people did and elicit information regarding behaviors, actions, opinion and values, feelings, and knowledge about a situation (Merriam, 2009). Based on Merriam's recommendation, the types of questions for this study include ideal position questions and interpretive questions. According to Merriam, ideal position questions can be used with any phenomenon under study because they elicit both information and opinion from participants. Ideal position questions may also reveal both the positives and negatives of student and teacher beliefs about technology use in biology courses. Similarly, interpretive questions provide a check on what the researcher understands while allowing participants an opportunity to reveal additional information, opinions, and feelings. In addition, how participants answer interview questions may be unpredictable, so Merriam recommended the use of probes to follow up something already asked to gain additional information or clarity. Based on these guidelines, I developed six open-ended interview questions about students and teachers' use of technology innovations that were aligned with the research questions.

Table 1 is an alignment of the six student interview questions to the research questions for this study.

Table 1

Alignment of Student Interview Questions to Research Question

Student Interview Questions	*RRQ1*	*RRQ2*	*RRQ3*	*CRQ*
1. What types of technologies do you use in your biology course?	X			
2. Why do you believe that these technologies are or are not useful?	X			
3. Why do you believe these technologies are or are not easy to use?	X			
4. How do you believe that your experiences with these technologies have impacted your learning in biology class?	X			
5. What factors do you believe influence your acceptance of technology in biology class?	X			
6. What factors do you believe influence your learning of biology content when you use technology?	X			

Table 2 is an alignment of the six teacher interview questions to the research questions for this study.

Table 2

Alignment of Teacher Interview Questions to Research Questions

Teacher Interview Questions	*RRQ1*	*RRQ2*	*RRQ3*	*CRQ*
1. What technologies do you use in your biology course?		X		
2. Why do you believe that these technologies are or are not useful?		X		
3. Why do you believe these technologies are or are not easy to use?		X		
4. How have your experiences with these technologies impacted Hmong student learning in biology classes?		X		
5. What factors do you believe influence Hmong student acceptance of technology in biology classes?		X		
6. What factors do you believe influence Hmong student learning of biology content when they use technology to assist them?		X		

Reflective Journals

The reflective journal questions are based on research related to the TAM that Davis (1985) developed and that forms the conceptual framework for this study. The four constructs of technology use in this model include outcome expectancy, TTF, social influence, and personal factors. Outcome expectancy is the user's acceptance of technology based on perceived usefulness and actual use of a technology. TTF is the degree of ease associated with the use of technology and the degree to assist an individual in performing a task. Social influence is the relationship with others and the pressure to perform or use technology. Personal factors included self-efficacy, learning styles, and cultural values that may influence technology acceptance. These four constructs served as the foundation to the reflective journal questions for both students and teachers. The reflective journal questions for both teachers and students were designed to be in alignment with the central research question and the TAM.

Table 3 presents an alignment of the four teacher reflective journal questions to the research questions for this study.

Table 3

Alignment of Teacher Reflective Journal Questions to Research Questions

Teacher Reflective Journal Questions	*RRQ1*	*RRQ2*	*RRQ3*	*CRQ*
1. How does the technology that you use in your biology course reflect your expectations for student outcomes?				X
2. How does the technology that you use in your biology course fit the task requirements of the content you are expected to teach?				X
3. What social influences do you believe reflect Hmong students' beliefs about the usefulness of technology in this biology course?				X
4. What personal factors do you believe influence Hmong students' beliefs about the usefulness of technology in this biology course?				X

Table 4 presents an alignment of the four student reflective journal questions to the research questions for this study.

Table 4

Alignment of Hmong Student Reflective Journal Questions to Research Questions

Student Reflective Journal Questions	*RRQ1*	*RRQ2*	*RRQ3*	*CRQ*
1. How does the technology that you use in your biology course reflect what you are expected to learn?				X
2. How does the technology that you use in your biology course fit the task requirements for the content you are expected to learn?				X
3. What social influences do you believe reflect your beliefs about the usefulness of technology for this biology course?				X
4. What personal factors do you believe influence your beliefs about the usefulness of technology in this biology course?				X

Document Data Collection Form

This instrument is based on the research of Merriam (2009) about how to conduct a content analysis for qualitative research. Content analysis, Merriam noted, is a process that involves raw data coding and construction of categories that capture relevant characteristics of the document’s content in order to determine key topics, insights, themes, and recurring patterns of meaning. For this study, the content of specific documents were described in relation to their purpose, organizational structure, content, and use. Documents were collected because the innovative biology courses at the research site are part of the PLTW biomedical science program, and curricular, instructional, and assessment documents are critical to understanding the nature of this program and its related courses. The documents selected for this study included state standards in science, group results from the end-of-course assessments, and instructional guidelines. I planned to describe the alignment of this innovative biology course to the state science performance standards, common core state standards, and next generation science standards that reflect both science and technology expectations. Describing group results for the end-of-course assessments provided an overview of how all students performed in science and in PLTW courses because group data on Hmong students were not available. Lastly, instructional guidelines provided a description of the courses, expectations, outcomes, units, lessons, and activities relating to biology and technology.

Table 5 presents a summary of the alignment of the criteria related to the observation data collection form to the third related research question.

Table 5

Alignment of Content Analysis Constructs to Research Questions

Criteria	*RRQ1*	*RRQ2*	*RRQ3*	*CRQ*
Purpose			X	
Organizational structure			X	
Content			X	
Use			X	

Procedures for Recruitment, Participation, and Data Collection

For this study, I followed specific procedures for recruitment, participation, and data collection to ensure the trustworthiness of this research. Recruitment, participation, and data collection procedures were addressed for each data source, including student and teacher interview guides, reflective journals, and documents regarding the innovative biology courses. These procedures were described below.

In relation to recruitment, I contacted the district office personnel in charge of the division of research and evaluation to request permission to conduct research in the district. As part of the district requirements to conduct research, I completed an application to conduct research that aligned with the district's board policies, goals, and strategies, and I submitted the application for review by the established due date. After the district application was reviewed and approved, I contacted and set up a meeting with the principal to explain the purpose of my study and asked the principal to sign a letter of support to serve as my research partner (see Appendix B). In addition, I asked the principal to provide me with the names and contact information of all potential teacher and student participants who meet the inclusion criteria. The district and school FERPA policies permit release of student names and ethnic identities to me. Schools may disclose, without consent, information such as a student's name, address, telephone number, date and place of birth, honors and awards, grades, gender, race/ethnicity, school, economically disadvantaged, disability status, and dates of attendance. The administrative policies of the public-school district in the Midwestern region of the United States, Administrative Policy 8.42 Student Records, confirmed the release of student names and ethnic identities. Pupil records are available to employees of the district and other school district who have been determined to have a legitimate educational interest to conduct research and surveys. In addition, the public-school district in the Midwestern region of the United States did not require special approval for teacher contact information. Teacher contact information such as phone number and e-mail address can be obtained publically on the school websites and did not require special approval. Depending on district requirements, the district personnel may require the principal to first send out an e-mail to eligible teachers and parents inviting them to participate in the approved study. I was able to follow up this initial contact with a mailing of letters of invitation and consent and assent forms to all potential participants.

Concerning participation, I mailed letters of invitation and consent forms to all teachers at the high school who teach this innovative biology course. I also mailed an invitation letter and consent form to any Hmong students over the legal age of 18 years old who are enrolled in the biology course. In addition, I mailed letters of invitation and assent and consent forms to all Hmong students enrolled in innovative biology courses who have not reached the legal age of consent and to their parents or legal guardians. The pool of participants at the potential research site included eight teachers and 84 students. In terms of participants, I needed the participation of two of the eight teachers (25%) and eight of the 84 students (9.5%). This pool is adequate enough in size to support a reasonable volunteer rate of 15-30% (Merriam (2009). I selected the first two teachers from each course who return a signed consent form to me. Similarly, I selected the first eight students who return a signed consent and assent form to me. After I have received all required consent and assent forms, I called the teachers and students and thank them for their willingness to participate in my study. During this conversation, I scheduled the interview dates and times during non-instructional time or before and after school. I conducted all interviews at the high school in an office conference room to ensure privacy. The length of the interview for each participant was scheduled for approximately 30 minutes. All teachers were asked the same teacher interview questions, and all students were asked the same student interview questions.

Concerning data collection procedures for the interviews, I prepared all necessary materials for an effective interview. I printed out copies of my interview questions, checked the digital voice recorder to ensure that it is functional, and designated a backpack for storage of all essential interviewing materials, including an extra set of batteries, a battery charger, a stopwatch, an extension cord, a back-up voice recorder, notepads, and writing utensils. The night before the interview, I called the participants and verified the date, time, and place of the interview. On the day of the interview, I arrived 15 minutes early with all materials prepared. In meeting the participants, I introduced myself and greeted them with a smile and a firm handshake, and thank them for taking the time out of their busy schedule to meet with me. I began the interview by providing the participant with a copy of the interview questions, and when the participant was ready, I started the timer on the stopwatch to keep track of time and started the interview process. After the interview, I thanked the participant for his or her support and reminded him or her that although I will not conduct further follow-up interviews, I needed them to provide feedback about the tentative findings of this study at a later date.

In relation to data collection procedures for the reflective journals, I explained the procedures to participants at the end of the interview. Each participant was given a hardcopy of the four reflective journal questions along with a self-addressed envelope that included my return address. I kindly asked and requested each participant to answer the questions to the best of their ability as possible and return the answers in the self-addressed envelope provided to them within two weeks from the interview date. In addition, I asked the participants if they would like to receive an electronic copy of the reflective journal questions to complete via computer. If participants choose to complete the questions via computer, I asked for their e-mail address and sent a copy instantly to them before I left the interview site. After receiving the reflective journal, I sent a copy of the reflective journal responses to participants via postal mail or e-mail for their records.

Concerning data collection procedures for the documents, I collected them from the teachers, principal and district or state websites. From the principal and teachers, I collected group results on the end-of-course assessments for the innovative biology courses. From the district and state websites, I collected information on state science standards. From the PLTW website and the teachers, I collected instructional guidelines such as course descriptions and standards alignment, sample unit plans, and sample lesson plans.

Data Analysis Plan

For this case study, I conducted data analysis at two levels. At the first level, I conducted a single case analysis for the four embedded cases or course sections, and at the second level, I conducted a cross-case of embedded units. Before I conducted data analysis, however, I gathered, transcribed, and organized the interview and reflective journal data into computer files. In terms of transcription, I transcribed the audio recorded interview data by myself. At the first level, which is the single case analysis done within each unit of analysis, I coded and categorized the data for each source for each embedded case. Merriam (2009) referred to this analysis as within-case analysis where "each case is first treated as a comprehensive case in and of itself" so that "the researcher can learn as much about the contextual variables" as possible (p. 204). During the embedded units of analysis, I used the process of coding to aggregate the textual data into small groups of information and develop a list of tentative codes that match text segments (Creswell, 2013). The coding process involved the use of the Microsoft Word software to create a code document as recommended by Hahn (2008) for level one coding or initial coding, and the use of line-by-line coding that Charmaz (2006) recommended for qualitative research. Line-by-line coding requires "naming each line of your written data" that allowed you to stay as close to the data as possible (Charmaz, 2006, p. 50). This coding allowed me to select, separate, sort, and label segments of data that can be used to describe information and to construct categories. Through this coding, I was able to categorize "segments of data with a short name that simultaneously summarizes and accounts for each piece of data" (Charmaz, 2006 p. 43). After coding, I constructed categories from the coded data by using the constant comparative method that Merriam (2009) recommended for qualitative research. The constant comparative method is a systematic strategy for analyzing any data set that does not result in a substantive theory but establishes analytic distinctions and comparisons. This method required the comparison of data to find similarities and differences.

At the second level, which is the cross case analysis, I examined the data for emerging themes and discrepant data, which formed the key findings for this study. In this study, I examined the coded and categorized data across all sources of evidence and across all cases for emerging patterns, themes, and relationships. These findings were analyzed in relation to the central and related research questions and interpreted in relation to the literature review and the conceptual framework of the study. In terms of discrepant data, I looked for any significant discrepancies between and among all data sources that challenge the theoretical proposition (Yin, 2014) for this study, which is the impact of technology innovations on science learning for Hmong students. The theoretical proposition for this study is that although Hmong students often struggle with learning science as indicated in the literature review, the impact of technology innovations on science learning for Hmong students was positive.

Evidence of Trustworthiness

Trustworthiness is important to qualitative research to ensure that the study is conducted in an ethical manner and to produce valid and reliable knowledge or results that are true to readers, practitioners, and other researchers (Merriam, 2009). A researcher's careful design of a study is a strategy for making the study trustworthy and accepted. The trustworthiness of qualitative research can be enhanced based on the constructs of credibility, transferability, dependability, and conformability. This section addresses specific strategies that I used to improve the trustworthiness of this qualitative research.

Credibility

For qualitative research, Merriam (2009) defined credibility as internal validity that deals with how research findings match reality to present a holistic interpretation of what is happening between the research and the real world. Merriam also recommended that qualitative researchers use the following strategies to improve the credibility of qualitative research: triangulation, member checks, adequate engagement in data collection, researcher's position or reflexivity, and peer examination or peer review. For this study, I used the strategy of data triangulation by comparing and contrasting multiple sources of data such to support my findings. Triangulation allowed me to compare and crosscheck data collected from teachers and students at different times and locations, because they may have different perspectives. I also used the strategy of member checks by seeking participant feedback on the credibility of the preliminary results to ensure that I truly captured and interpreted their perspectives and provided an opportunity for them to give me feedback. I also used the strategy of adequate engagement in data collection by collecting data at the site and spending several days at the research site in order to conduct interviews and collect documents.

Transferability

For qualitative research, Merriam (2009) defined transferability as external validity that is "concerned with the extent to which the findings of one study can be applied to other situations" (p. 223). Merriam recommended the following strategies to improve the transferability of qualitative research in generalizing findings to other settings or people: rich thick description and maximum variation. For this study, I used rich thick description by providing a highly detailed description of the setting and participants of the study. Merriam defined rich thick description as "providing enough description to contextualize the study such that readers will be able to determine the extent to which their situations match the research context, and, hence, whether findings can be transferred" (p. 229). In addition, I provided a detailed description of the data collection and analysis protocols, and the findings of the study. Although Merriam noted that maximum variation sampling and typicality of the sample are strategies that can be used to maximize transferability in qualitative research, I did not use these strategies. Instead, careful attention was given to selecting a unique study sample pertaining to one ethnic group.

Dependability

Dependability, which is the qualitative counterpart to reliability, is defined by Merriam (2009) as "the extent to which research findings can be replicated" (p. 220). In other words, dependability is the ability of a study to be repeated and yield the same results or the results are consistent with the data collected so that the study can be considered dependable. Merriam recommended that the following strategies that qualitative researcher can use to ensure for dependability: triangulation, peer examination, investigator's position, and audit trail. Similar to credibility, I used the strategy of triangulation to obtain consistent and dependable data. In addition, I used the strategy of an audit trail by maintaining a researcher's journal to document how data were collected, how coding was done, how categories were constructed, how themes were determined, and how decisions were made throughout the study. The audit trail journal included a running record of my reflections, questions, and decisions regarding problems, issues, or ideas that I have encountered during data collection, analysis, and interpretation.

Confirmability

Confirmability is the qualitative counterpart to objectivity. Merriam (2009) noted that a "researcher's values and expectations influence the conduct and conclusions of the study" (p. 220). Therefore, the objectivity of a qualitative study can be improved by using the strategy of reflexivity, which Merriam defined as the process of "critical self-reflection by the researcher regarding assumptions, worldview, biases, theoretical orientation, and relationship to the study that may affect the investigation" (p. 229). The use of the strategy of reflexivity explained my biases, dispositions, and assumptions regarding the research so I can make my perspectives, biases, and assumptions clear to the reader. I used a researcher's journal to record my experiences during the research process so that I reflect upon and understand my personal biases about the use of technology in biology classrooms. These reflections helped me ensure that my personal biases do not influence the findings of this study.

Ethical Procedures

The trustworthiness of qualitative research depends on how researchers follow ethical procedures. Therefore, ethical practice in this study reflects my values and ethics as an individual researcher. My decisions about how to manage data and determine findings did have a direct impact on the trustworthiness of this study. To ensure that this study was carried out with integrity, Merriam (2009) suggested that researchers consider such ideas as the protection of subjects from harm, the right to privacy, the notion of informed consent, and issues of deception in order to protect both participants and their environments. With a responsibility to protect my participants and their environment, I followed Walden University guidelines to ensure my implementation of ethical practices in conducting this study.

For this study, I followed ethical procedures by submitting an application to the Institutional Review Board (IRB) at Walden University and received IRB approval with an approval number of 05-31-17-0178474. The IRB application took into consideration the ethical principles of beneficence, justice, and respect for persons. Beneficence involves maximizing possible benefits and minimizing possible harms. Justice involves fairly distributing the benefits and burdens of research and having respect for persons by acknowledging participants' autonomy and protecting those individuals with diminished autonomy. The IRB application contained the following relevant information in order to be in compliance with federal regulations and university policies: (a) proposed data collection and analysis procedures, (b) community research stakeholders and partners, (c) potential risks and benefits, (d) data integrity and confidentiality, (e) potential conflicts of interest, (f) data collection tools, (g) research participants, and (h) informed consent.

To ensure that my research complies with international, federal, and university guidelines, I took the following steps to ensure the protection and the right to privacy of all participants. The ethical concerns pertinent to this study were considered before, during, and after data collection. Each of the following dimensions of ethical practice were considered.

Cause no harm. Participants were not harmed in this study. At any time if participants feel discomfort, they are free to withdraw from the study. The study did not cause embarrassment to participants or dehumanize them in any way. Participants were not asked to do anything unusual or outside of daily expectations.

Obtain legal consent. I obtained a letter of cooperation from the appropriate personnel at the district office and a letter of support from the school principal. I also obtained letter of consent and assent from all participants. For students, two separate forms were sent, including a letter of consent to the parents/guardians of the students and a letter of assent to minor students. For teachers, a letter of consent was sent directly to each of the participating teachers. These procedures ensured that all participants were informed about the purpose of the research. In this way, I did not interview any students or teachers unless they have signed the consent form. The consent form explained that I am a graduate student at Walden University, conducting a qualitative research study as a requirement for a doctoral degree in education. I was still responsible for my duties as an administrator. In addition, participation was voluntary and not part of the student or teacher's work, and was also not compensable.

Maintain confidentiality and anonymity. Confidentiality was maintained by removing teachers and students' names from the interview guides and reflective journals. To ensure that participant identities are not directly or indirectly disclosed, the results section did not include any data that would render any particular participants identifiable. In place of the actual name, pseudonyms consisted of the word Student follow by a number such as Student 1, Student 2, and so on to account for all students. Similarly, pseudonyms were used for all teacher participants. The students and teachers' identities were not revealed, and their responses were confidential. In addition, the identity of the school was not revealed. I used pseudonyms for the school district, the school, and the participants. All participant data were stored in a password protected flash drive or computer, and hard copy data were stored in a secure location at my house.

Insure that benefits outweigh risks. The potential risk or harm to the students and teachers is minimal and are outweighed by the benefits. This research may benefit participants, the school educators, and school district educators because the study may provide insight into why Hmong students struggle in science and may fill gaps in the research literature related to understanding the perceptions of Hmong students about how they use technology to learn science. This study may also provide educators with a deeper understanding about how teachers can provide effective science instruction for Hmong students and may provide solutions to some of the challenges that Hmong students face when learning science.

Summary

This chapter included a description of the research design and rationale, role of the researcher, methodology, evidence of trustworthiness, and ethical procedures. In terms of research design and rationale, I selected a single case study research design to investigate the impact of technology innovations in high school biology courses on science learning for Hmong students. My role in this study is to serve as the primary investigator in which I am responsible for the selection of the research design, participants, data sources, and data collection instruments. In addition, I am responsible for data collection, data analysis, and data interpretation. In terms of methodology, participant selection included a sample size of eight Hmong high school students and two high school biology teachers who were invited and selected from a pool of potential participants that meets inclusion criteria and return of signed consent. The instrumentation for this case study methodology included interview guides, reflective journals, and a document data collection form. In addition, procedures for recruitment, participation, data collection, and data analysis were described in the methodology section. Recruitment and participation plans included letters of invitation, letters of consent, and letters of assent. Data collection plans included the collection of interview guides and reflective journals from teachers and students, and the collection of documents from principals and district websites. Data analysis plans included single case analysis of each data source for each case, using Microsoft Word and Excel software and line-by-line coding (Charmaz, 2006) to construct categories using the constant comparative method to find similarities and differences among the data. Cross case analysis involved examining coded and categorized data across all sources of evidence for emerging patterns, themes, and relationships to determine the findings or results of the study. The results were analyzed in relation to the central and related research questions and interpreted in relation to the conceptual framework and the literature review. Concerning issues of trustworthiness, the strategies of triangulation, adequate engagement in data collection, reflexivity, an audit trail, and rich, thick descriptions were used to improve the credibility, transferability, dependability, and conformability of this qualitative research. Furthermore, consideration of ethical concerns included compliance with federal regulations and university policies so that this study caused no harm, involved legal consent, maintained confidentiality and anonymity, and insured that benefits of the research outweigh risks to participants.

Chapter 4: Results

The purpose of this qualitative case study was to describe how technology innovations in high school biology courses impact science learning for Hmong students based on a TAM. To accomplish this purpose, I analyzed student and teacher data from three different sources using the conceptual framework of the TAM that includes the constructs of outcome expectancy, TTF, social influence, and personal factors (Gu et al., 2013). First, I analyzed student interview and journal data to better understand how Hmong students perceive the usefulness and ease-of-use of technology innovations in high school biology courses, then I did the same with the teacher data. Next, I analyzed biology course documents to determine how technology innovations are used in lessons that Hmong students took at the high school. The course documents included local and national standards alignment of biology and technology, instructional guidelines such as unit and lesson plans, and End of Course assessment. The central research question for this study was: How do technology innovations in high school biology courses impact science learning for Hmong students based on a technology acceptance model? The related research questions included the following:

1. How do Hmong students perceive the usefulness and ease-of-use of technology innovations in high school biology courses?
2. How do high school biology teachers perceive the usefulness and ease-of-use of technology innovations for Hmong students in their courses?
3. What do course documents reveal about how technology innovations are integrated into high school biology courses?

Chapter 4 is about the results of this study and includes the following sections: setting, demographics, data collection, data analysis, evidence of trustworthiness, and results. In the Setting section, I describe personal and organizational conditions that may have influenced participants or their experience at time of study and therefore may influence interpretation of the study results. In the Demographic section, I describe participant characteristics relevant to the study. The number of participants, duration of data collection, how data were recorded, variations in data collection from Chapter 3, and unusual circumstances encountered in data collection are discussed in the data collection section. The Data analysis section contains the coding process along with specific codes, categories, themes that emerged from the data, and qualities of discrepant cases. In the Evidence of Trustworthiness portion, I describe implementation and/or adjustments to strategies of creditability, transferability, dependability, and confirmability. The bulk of the chapter is the Results section where I present the findings and describe patterns and themes related to each research question. I also discuss discrepant cases or nonconforming data. The chapter concludes with a summary of the study's findings to the central research question and the related research questions and provides transition to Chapter 5.

Setting

The setting for this case study involved an innovative biology course at an urban public charter high school in the Midwestern region of the United States. Great Academy (pseudonym) is a college preparatory high school serving 256 students in Grades 9 through 12. Great Academy is located in a public school district and is located in a racially and ethnically diverse city with a population of about 600,000 and includes the largest Hmong population in the state. Great Academy is a title I economically disadvantaged school where 82% of the student population receive free or reduced breakfast and lunch, 5.3% are students with disabilities who received special education services, and 15.3% are limited English proficient students who received English language services (Wisconsin Department of Public Instruction, 2017). The student ethnicity consisted of a total minority enrollment of 99% where 97% are Asian, 1% are African-American, 1% are Hispanic, and 1% are Caucasian. Great Academy was identified as a high performing school with proficiency scores in math and English, and recognized as a bronze medal school of excellence (U.S. News & World Report, 2017).

Demographics

This single case study included two units of analysis, each including a single teacher and a group of students from the innovative biology course. As part of the course, students learned biology content through innovative technology and teachers led and facilitated experiences on the learning and usage of the innovative technology in biology, using both educational and biology technologies. Ten participants were included in this single case study; eight of the participants were students and two were teachers. The eight student participants included three males and five females. All students were current students enrolled in the innovative biology course. The two teacher participants included two male science teachers who are trained and nationally certified in teaching the innovative biology course.

Embedded Unit of Analysis 1: Participants in Innovative Biology Course A

Mr. Adams (pseudonym) taught high school science at the high school for 3 years. Mr. Adams was trained to teach three sections of the innovative technology course—two in engineering and one in biology. In 2016, Mr. Adams provided instruction for 61 students. Mr. Adams earned a bachelor's degree in secondary education with certification in broadfield science and chemistry. Mr. Adams had 5 years of teaching experiences in science and 3 years of teaching experiences in innovative technology science course.

Amy (pseudonym) is a twelfth grade female student. She attended Great Academy since ninth grade where she took both general science courses and innovative science courses. In 2016, Amy was enrolled in seven class sections: two history classes, two literature classes, one math class, and two science classes. Amy had used innovative technologies during her 4 years at Great Academy.

Beth (pseudonym) is a twelfth grade female student. She attended Great Academy since ninth grade where she took both general science courses and innovative science courses. In 2016, Beth was enrolled in seven class sections: two history classes, two literature classes, one math class, and two science classes. Beth had used innovative technologies during her 4 years at Great Academy.

Cora (pseudonym) is a twelfth grade female student. She attended Great Academy since ninth grade where she took both general science courses and innovative science courses. In 2016, Cora was enrolled in seven class sections: two history classes, two literature classes, one math class, and two science classes. Cora had used innovative technologies during her 4 years at Great Academy.

David (pseudonym) is a twelfth grade male student. He attended Great Academy since ninth grade where he took both general science courses and innovative science courses. In 2016, David was enrolled in seven class sections: two history classes, two literature classes, one math class, and two science classes. David had used innovative technologies during his 4 years at Great Academy.

Embedded Unit of Analysis 2: Participants in Innovative Biology Course B

Mr. Banks (pseudonym) taught high school science at the high school for 10 years. Mr. Banks was trained to teach eight sections of the innovative technology course——four in engineering and four in biology. In 2016, Mr. Banks provided instruction for 140 students. Mr. Banks earned a bachelor’s degree in secondary education with certification in broadfield science, biology, physical science, and physics. Mr. Banks had 10 years of teaching experiences in science and 8 years of teaching experiences in innovative technology science course.

Eva (pseudonym) is a tenth grade female student. She attended Great Academy since ninth grade where she took both general science courses and innovative science courses. In 2016, Eva was enrolled in seven class sections: one math class, two literature classes, one physical education class, and two science classes. Eva had used innovative technologies during her 2 years at Great Academy.

Flo (pseudonym) is an eleventh grade female student. She attended Great Academy since ninth grade where she took both general science courses and innovative science courses. In 2016, Flo was enrolled in seven class sections: one physical education class, one history class, two literature classes, one math class, and two science classes. Flo had used innovative technologies during her 3 years at Great Academy.

Guy (pseudonym) is an eleventh grade male student. He attended Great Academy since ninth grade where he took both general science courses and innovative science courses. In 2016, Guy was enrolled in seven class sections: one health class, one history class, two literature classes, and two science classes. David had used innovative technologies during his 3 years at Great Academy.

Henry (pseudonym) is a ninth grade male student. This was his first year attending Great Academy where he took both general science courses and innovative science courses. In 2016, Henry was enrolled in seven class sections: one history class, one art class, two literature classes, one math class, and two science classes. This was the first year that Henry used innovative technologies at Great Academy.

Data Collection

In this study, I collected data from multiple sources including face-to-face interviews with individual students and teachers, reflective journals from both students and teachers, and course documents from the teachers. Other relevant data required for the setting and demographics sections were also collected from the school secretary relating to student enrollment, student course loads, grade level, teacher experiences, teacher course loads, and teacher section roster. The data collection process of interviewing, generating transcripts from audio-recordings, receiving reflective journals, and gathering course documents from eight students and two teachers started on August

7, 2017 and ended on January 26, 2018. All data sources were stored on a password-protected USB drive. I created an electronic folder on the USB drive named Data Collection. Within this folder, I also created three subfolders named Course Documents, Interview Guide, and Reflective Journal. The Course Documents folder contained three additional subfolders named Assessment, Instructional Guidelines, and State Standards. The Interview Guide folder contained two subfolders named Student Interview and Teacher Interview. The Reflective Journal folder contained two subfolders named Student Journal and Teacher Journal. All data were stored in their respective folders.

Interviews

The data collection process for the interviews required setting up the interviews, conducting the interviews, recording the interviews, and transcribing the recorded interviews. The initial plan was to conduct both student and teacher interviews during a 2-week period from June 12 to June 23, 2017. However, this time was a challenge to reach both students and teachers as school was ending and teachers were occupied with closing procedures. I was able to contact all participants in July and scheduled interviews for August. I conducted student interviews over a 2-week period between August 7 and August 25, 2017. The first four student interviews were conducted during the week of August 7 to August 11, 2017. The last four student interviews were conducted during the week of August 21 to August 25, 2017. All student interviews were conducted in a face-to-face meeting and took place at Great Academy in a secluded room. All interviews were recorded using the app Voice Recorder on an iPhone 8 Plus. Once recorded, each interview was saved as an audio file in the format of MPEG 4 Audio (M4A) and imported to the folder named Interview Audio Files on the USB flash drive. Amy's interview was on August 7, 2017 for a duration of 8:21 minutes. Beth's interview was on August 7, 2017 for a duration of 9:24 minutes. Cora's interview was on August 9, 2017 for a duration of 6:48 minutes. David's interview was on August 11, 2017 for a duration of 9:13 minutes. Eva's interview as on August 22, for a duration of 7:25 minutes. Flo's interview was on August 23, 2017 for a duration of 11:27 minutes. Guy's interview was on August 24, 2017 for a duration of 10:35 minutes. Henry's interview was on August 23, 2017 for a duration of 12:21 minutes. Students' interview times ranged from six minutes to 12 minutes. In addition, teachers' interviews were also conducted in August at the same location. Mr. Adams' interview was on August 21, 2017 for a duration of 6:31 minutes. Mr. Banks' interview was on August 21, 2017 for a duration of 12:42 minutes. Similar to students' interview time range, teachers' interview time also ranged from six minutes to 12 minutes.

After recording the interviews, the next step was to transcribe the audio recordings to prepare for data analysis. I transcribed the audio files using the downloaded app F5 Transcription on a MacBook Pro. All participant transcriptions generated on the F5 Transcription app were copied and pasted into Microsoft Word to be used as transcription file for each perspective participant.

There were no variations in data collection from the plan presented in Chapter 3. I did not encounter any unusual circumstances during the collection of data for the interview guide. The interviews went smoothly as scheduled and the participants arrived on time.

Reflective Journals

After the interview with the participants, both students and teachers were provided with a copy of the reflective journal questions. A hard copy (paper copy) of the reflective journal questions was provided to each participant along with a self-addressed envelope at the end of the interview session. In addition, a soft copy (electronic copy) was sent via e-mail to each participant at the end of the interview session. Before the participants exited the interview, I explained to them that they have the option of mailing in their responses via postal mail or via e-mail. I also asked for the participants to complete the four reflective journal questions within a 2-week time frame.

For student reflective journals, Amy's interview was on August 7, 2017 and she returned her reflective journal responses on August 14, 2017 as an attachment via e-mail. Beth's interview was on August 7, 2017 and she returned her reflective journal responses on August 19, 2017 as an attachment via e-mail. Cora's interview was on August 9, 2017 and she returned her reflective journal responses on August 21, 2017 via shared Google Docs. David's interview was on August 11, 2017 and he returned his reflective journal responses on August 22, 2017 as an attachment via e-mail. Eva's interview was on August 22, 2017 and she returned her reflective journal responses on August 23, 2017 as an attachment via e-mail. Flo's interview was on August 23, 2017 and she returned her reflective journal responses on September 22, 2017 as an attachment via e-mail. Guy's interview was on August 24, 2017 and he returned his reflective journal responses on September 21, 2017 as an attachment via e-mail. Henry's interview was on August 23, 2017 and he returned his reflective journal responses on September 8, 2017 as an attachment via e-mail. All student reflective journal responses were downloaded and saved in the Student Journal folder.

For teacher reflective journals, Mr. Adams' interview was on August 21, 2017 and he returned his reflective journal responses on August 23, 2017 as an attachment via e-mail. Mr. Banks' interview was on August 21, 2017 and he returned his reflective journal responses on January 26, 2018 as an attachment via e-mail. All teacher reflective journal responses were downloaded and saved in the Teacher Journal folder.

There were no variations in data collection of the reflective journals. However, although I had the expectation that not all responses may return, seven of the eight students returned their responses on time. Flo was the only one who did not turn in her responses on time but after sending a follow up e-mail, she admitted that she forgot and would complete it. It took Flo about one month to return her responses to me after her interview date. For teacher responses Mr. Adams completed his responses and returned it within 2 days. On the other hand, it was a challenge to obtain the responses from Mr. Banks. After the 2-week period, I sent Mr. Banks a reminder e-mail. From September to January, several attempts were made to obtain Mr. Banks' journal responses. On January 26, 2018, I received Mr. Banks' journal responses as an attachment via e-mail.

Course Documents

All course documents were obtained from the teachers. I requested ahead of time for the two teachers to print out a sample of their lesson plan and unit plan, a copy of the course descriptions and standards alignment, and a copy of all End of Course assessment scores. On July 14, 2017, I went to Great Academy and obtained the course documents from Mr. Adams. Mr. Adams also provided a website where I can retrieve the course documents given to me. The teachers were very cooperative in supporting me with the required course documents. Thus, there were no variations or unusual circumstances that I encountered while collecting the course documents.

Data Analysis: Level 1

For this single case study with embedded units of analysis, I conducted data analysis at two levels, and used the process of coding to aggregate the textual data into small groups of information and develop a list of tentative codes that match text segments (Creswell, 2013). At the first level, I coded and categorized the data for each source for each embedded case. I used the technique of within-case analysis as recommended by Merriam (2009) and the line-by-line coding that Charmaz (2006) recommended for qualitative research. These coding techniques allowed me to select, separate, sort, and label segments of data that can be used to describe information and to construct categories of level 1 codes. I used the constant comparative method that Merriam (2009) recommended for constructing categories. I also presented a summary table of how I separated codes out from each data source to form level 1 codes.

Analysis of Interview Data: Hmong Student Perceptions

With line-by-line coding, I was able to identify raw text data that inspired the level 1 code. Then, I used the level 1 code to categorize or collapse the level 2 code. Here is an example of how I arrived at the perspective level 1 and level 2 code. For the first interview question, I labeled words such as computers, desktops, and laptops to arrive at the level 1 code of computers. In other words, desktops and laptops were categorized into the code computers to show that computer is a type of technology students used in biology. Similarly, text such as LoggerPro and learning module system were used to form the level 1 code of software. In addition, I also looked for text data pertaining to other technologies that may not fall under the category of computers or software. The coding of words such as gel electrophoresis, microscopes, diffuser, scalpel, utensils, caliper, centrifuge, vortexer, electronic and manual micropipettes, and hot water baths were used to categorize these technologies as lab tools for level 1 coding. The coding of words such as probes, heart rate monitor, LabQuest mini, EKG electrodes, spirometer, and O2 gas sensor were used to form the level 1 coding of probes and sensors. Also, the level 1 coding of medical tools was categorized from medical technologies, stethoscope, blood pressure cuffs, and pocket fetal Doppler. The five level 1 code indicate that the types of technologies students used include computers, software, lab tools, medical tools, and probes and sensors. Furthermore, I categorized the two level 1 code of computers and software into the level 2 code of educational technology. Similarly, I categorized the three level 1 code of lab tools, medical tools, and probes and sensors into the level 2 code of biology technology. The two level two codes indicate that students used both educational technology and biology technology in their biology course. Further analysis of each interview question was explained in the sections below.

Student interview question 1. Students were asked to respond to six interview questions to determine how Hmong students perceive the usefulness and ease-of-use of technology innovations in high school biology courses. The first interview question was: What types of technologies do you use in your biology course? For embedded unit of analysis 1, three of the four students: Amy, Beth, and David stated that the main use of technology in the classroom is the computer while Cora indicated that the most technology usage is the microscope. David added that:

> I would say we have used a lot of technologies throughout the biology course. I think the main technology we use is laptop with Internet access because most of our work is done on the laptop. Mostly it is independent work and most of what we do, we do it on the laptop.

Other than computers, all four students said they used lab tools, medical tools, and probes and sensors. Beth and Cora indicated the use of lab tools such as gel electrophoresis, microscopes, and gel diffuser. Amy and Beth reported the use of medical tools such as heart rate monitor, stethoscope, and blood pressure cuffs. As for probes and sensors, Beth and David said they have used hand sensors and probes to measure blood pressure, heart rate, pulse, and breathing. Overall, the types of technologies used in the innovative biology course by students in the embedded unit of analysis 1 included computers, lab tools, medical tools, and probes and sensors.

For embedded unit of analysis 2, all four students: Eva, Flo, Guy, and Henry said they have used computers in the classroom. Other than computers, Eva and Guy reported software as a type of technology used in the classroom. While students normally use computers to complete their work, they also use the computer to run data collection software. Flo stated "we usually use the computer to enable software like LoggerPro and we use those to find out what our breathing rate is, our heart rate and all other things related to the body." Guy added "when we use the computer, we also used the program like LoggerPro to collect data for our required task asked on the lab." Besides the use of computers and software, Henry mentioned the use of an on-line learning module system (LMS). According to Henry, all of the course work is located online where he can access daily lessons.

Similar to students in the embedded unit of analysis 1, students in the embedded unit of analysis 2 also used lab tools, medical tools, and probes and sensors. Flo and Henry reported the use of lab tools as a type of technology. The lab tool technologies included scalpel and utensils, electronic caliper, electronic quantitative scale, centrifuge, vortexer, electronic and manual micropipettes, gel electrophoresis apparatus, and hot water baths. In addition, Flo and Henry stated medical tools as a type of technology where they have used stethoscope and pocket fetal Doppler. Furthermore, Flo, Guy, and Henry added probes and sensors as a type of technology used in the classroom. Flo and Henry indicated that they have used probes and sensors to measure heartrate, breathing rate, grip strengths, oxygen level, and skin temperature but they do not know the actual name of the sensor technology. On the other hand, Guy was specific as to what the technology is. Guy stated:

> We would hook up a small device called a LabQuest mini to the desktop or laptop then we hook up sensors to the LabQuest mini that allows us to collect the data that we need. When we did reflexes of the human body, I think we used EKG electrodes because I remember my partner putting EKG electrode tabs on my knee. We also used spirometer and O2 gas sensor to measure our breathing and heartrate. Oh yes, we also used the spirometer for lung capacity.

Overall, the types technologies used in the innovative biology course by students in the embedded unit of analysis 2 included computers, software, learning module systems, lab tools, medical tools, and probes and sensors.

Student interview question 2. The second interview question was: Why do you believe that these technologies are or are not useful? In embedded unit of analysis 1, two themes were identified. The themes were hands-on experiences and important for task completion. All four students believed technologies are useful. The first theme is that the use of technology is useful to provide students with hands-on experiences. Beth and David believed technology is very useful because instead of learning about a concept or content in textbook, they get to experience it first hand and the hands-on experiences allows them to make better connection with the text. Thus, the hands-on experience made Beth believed that learning with technology is better than learning with textbook. Similarly, Cora added:

> These technologies are very useful because for example, for the microscope with our bare eyes we can never see those cells but the microscope was able to make us see how cells are like, how abnormal cells look like, like for real and under the microscope not just in pictures because in pictures it makes it hard to believe but when you actually look under the microscope you actually see how cells actually look like. So, it's very useful.

In addition, David believed that hands-on experience through technologies has helped him form understanding of what he is doing and the concept that he is learning. Other than hands-on experience, the second theme is that the use of technologies was also useful in terms of task completion. Amy believed that the use of computer to conduct research is useful because she can track whatever she is doing, save and backup her data, and use medical technologies to help complete data collection and analysis. Overall, technologies are useful for students in embedded analysis 1 because it provided students with hands-on experience and is important for task completion.

In embedded unit of analysis 2, all students also believed that technologies are useful. Five themes were identified as career exploration, easy access to resources, hands-on experience, important for task completion, and enhance learning and understanding. Flo believed technology is useful in providing career exploration. Flo added:

> In my career of interest, which is the health and medical filed, it allows me to see what kind of jobs there are out there being able to use these materials and equipment being they provided for us. It allows me to see whether or not I really like doing this kind of work and whether or not I will continue with that path or not.

In addition, Flo believed technology is useful because it provided easy access to resources at home. If she forgets her assignment at school, she can still go online and download her homework to complete off line.

Besides career exploration and easy access to resources, technology is also useful because it provided hands-on experience. Eva and Flo believed that using technologies in class allowed them to understand and see the function and purpose of the technologies. Eva believed the use of technology helps build experience in what she may encounter in the adult world. Similarly, Flo believed the use of heartrate monitor and sensors really help her as a student when she is able to see and experience first-hand how the tools work. Another reason why students found technologies useful is that it is important for task completion. Eva, Guy, and Henry supported technologies for task completion. They indicated that technologies allow them to collect data and if they cannot collect data then they will not be able to complete the task given to them. Also, technologies allow them to complete their work effectively and efficiently. Eva reported that without the computer and software then it would take too long to complete calculations for experiments. Similarly, Guy indicated that without the electronic caliper, it would be hard to use a ruler to measure the inside and outside measurements of the eye socket. While technology is useful for task completion, it is also a useful tool to enhance learning and understanding. Guy added:

> The caliper is useful to get accurate readings and to allow us to measure in narrow opening that we can't get a ruler into. All the sensors are very useful because without them we would not be able to measure our breathing rate, lung volume, lung capacity, strength of our hand grip, and our reflexes.

In addition, Henry added:

> I believe the technologies are useful because there is a purpose for us to use them to help us learn and become better student. We use laptops and computers to do research and to analyze data. I think this is important because it allows us to become familiar with the use of computer technology in our learning. Without calipers and scales, we would not be able to measure small areas and small

> amount of item. Without the micropipettes, we cannot get accurate measurements for DNA extraction. Without the centrifuge, we would not be able to spin the tubes to a high enough speed to separate the DNA. Also, without the gel electrophoresis apparatus then we cannot run our DNA and get our final gel product to analyze our results.

Thus, the use of technology is purposeful and important for task completion.

In addition, students also believed that the use of technology is useful to enhance learning and understanding. Both Flo and Henry believed the tools they used in class allows them to go deeper into the concept they are learning. Flo believed her learning is enhanced as she is able to understand each section of the organ and how the organ system works together to keep her alive. Also, Henry stated “I think all the technologies we used are very useful because they make learning science fun and helps us understand the process of science.” Overall, technologies are useful for students in embedded analysis 2 because it provided students with career exploration, access to resources, hands-on experience, task completion, and enhance learning and understanding.

Student interview question 3. The third interview question was: Why do you believe these technologies are or are not easy to use? In embedded unit of analysis 1, three themes emerged from the data. These themes were computers in general: familiar with, specific peripherals: follow instruction, and specific peripherals: not familiar with. However, there were contradicting beliefs regarding the ease of use of computer technologies and science technologies. Regarding theme one of the use of computers in general, all students believed they are familiar with how computers work so the use of computer technology was easy to them. Amy added "well the computers can be pretty self-explanatory. I think that a lot of youth and students now a day, we're use to technology so we can easily navigate them." Thus, students believed it is easy to use computer technologies. On the other hand, regarding theme two of the use of specific science peripherals or science technologies, two students believed specific peripherals are easy to use while two students believed specific peripherals are hard to use. Beth and David believed it is easy to use specific peripherals if you just follow the instruction. According to David, the science technologies are easy to use:

> For most of the time, these technologies are easy to use because it comes with instructions and it's very clear on how we should move from one step to another step. For most of the time, I would say these technologies are easy to use and they help us.

Although Beth and David believed specific peripherals can be easy to use, they also believed that it may be a challenge other times too. David indicated:

> There are times when a technology is hard to use even when the instruction is out there for you to use. For example, for me when we first did the blood pressure even though my teacher showed us how to do it with instructions, I had a hard time using that technology because it was my first time and I struggled a little bit to get used to it.

Similarly, Beth stated that sometimes the probes and sensors would not work right so the challenging part is to troubleshoot and get the probes and sensors to work correctly.

Even with going through the process of troubleshooting the technologies, Beth and David still believed it is easy to use specific peripherals.

Regarding theme three of not being familiar with specific peripherals, Amy and Cora believed the use of specific peripherals is not easy to use because they are not familiar with the technologies. For Amy, she believed it is hard to use science technologies that she has not heard of before or has not used before and the unfamiliarity with the technology will cause her to not know what to do. Amy believed that although it is hard to use the new technologies at first, if given the proper support then she can learn to use it:

> For those technologies that we haven't heard of much like those technologies used to hook up with the computer. We are not use to that so that is hard to use. And we need the instructor there to help us through or we need instructions there so we know what to do.

Similarly, Cora believed that science technologies are not easy to use but she can learn to use it too. Cora added:

> These technologies are not actually easy to use because with one mistake or just not knowing how to work it, it's not going to work and that can cause a lot of issues. But then when you're able to know how to use it, it can be or when you get used to it, it will be easy and it will be very useful. So, it's not really easy but you can learn.

Overall, students in embedded unit of analysis 1 believed computer technology is easy to use while science technology is both easy and hard to use.

In embedded unit of analysis 2, four themes emerged from the data. These themes were a) computers in general, b) familiar with specific peripherals: correct technologies, c) specific peripherals: follow instruction, and d) specific peripherals: not familiar with. In addition, students also think differently about the ease of use of computer technology and science technology. In terms of theme one, all students believed they are familiar with computers so the use of computer in general is easy to them. Flo added:

> I believe that some of these technologies are easy to use because they are self-explanatory. For example, the laptop, yes everyone knows how to use the computer and so it is very easy to use and very easy to comprehend how to use.

While students believed it is easy to use computers, they have varying beliefs regarding specific peripherals or science technologies. Regarding theme two, Flo believed specific peripherals are easy to use but you need to have the correct technologies:

> The technologies that we use for measuring the heartbeat and our breathing rate and our skin temperature and such things; those were a little trickier because not only do you have to have the technology but you also have to have the system in your computer that is already there and that will be able to read the data that you collect and that you test in order to be able to kind of translate what the certain lines or certain numbers on the screen means.

As for theme three, Guy believed specific peripherals are easy to use but you need to be careful and follow the instruction:

> At first, I didn't know how to use the sensors and how to connect the LabQuest mini to the computer. I think I messed up and put the input into the output and the output into the input and got some weird readings. I thought I knew how to do it and didn't read the directions. I think the technologies are easy to use but you have to be careful and read the manual to make sure you know exactly how to do it. The directions are easy to use and our teacher always give us a demo before we start.

While Flo and Guy believed it is easy to use specific peripheral technologies, Eva and Henry believed differently. Regarding theme four, specific peripherals may be hard to use if students are not familiar with the technology. Both Eva and Henry believed the use of specific peripherals is hard but with practice, it becomes easier. Eva indicated that at first it was not easy to use because she did not know what is what, and she needed someone who already knew what they are doing to help her out, but once she got the hang of it then it was easy to use and she was able to do more. Similarly, Henry added:

> When we first started using them, I thought it was hard but then I realized that I just need more practice and our teacher gives us time to practice. Also, if I am stuck then I can read the directions or ask my teacher for help. Sometimes, I also asked my friends to help me and they also asked me to help them.

Overall, students in embedded analysis 2 believed the use of computer technology is easy while the use of science technology may be both easy and hard.

Student interview question 4. The fourth interview question was: How do you believe that your experiences with these technologies have impacted your learning in

biology class? In embedded analysis 1, three themes emerged from the data. These themes were that students believed that technologies impacted their learning with deeper understanding, increase memory and interest, and technology is a part of the course to complete task. Three students suggested that technologies impacted their learning while one student indicated that technology has a huge impact on their learning. Regarding theme one, David indicated a deeper understanding through the use of technology: "Instead of learning all the time we get to do something in the class that is related to what we are learning and by doing that we're able to remember more to help us more."
In addition, David stated that technologies have made learning more fun and gave him more memories in science class where he is engaged in the use of technologies. Also, David added:

> I believe the experiences with these technologies have impacted me by making the learning more fun and giving me more memories. Also, the experience with the technology made me want to learn more because I want to know how does this technology work, and I can use this technology.

As technology impacted David, the use of technology also impacted Beth. In terms of theme two, Beth believed technology impacted her memory and interest in science: "I do believe that my experiences have been impacted with the technologies. I feel like because I had a more hands-on learning experience, I was better to remember it more and I was more interested in the class." Cora added that technology impacted her understanding of science:

> Because of these technologies, well I want to say thanks to these technology because I'm kind of those people who don't really believe until I see it or like I do it myself and so if just learning through textbook or through lectures that's not going to help us because English is our second language so when they are explaining or we read the textbook we are not going to understand every single words and so these technologies make us believe and understand what the word is or what the textbook is trying to say.

While Beth, Cora, and David reported that technologies have an impact on their learning, Amy reported that technologies have a huge impact on her learning where technology is a part of the course to complete assigned task. Regarding theme three, Amy added:

> I think that technology has been a huge impact. I feel that when I'm in a biology course or something, there's always something to do with technology so I feel like it's become like part of the course. Knowing what to do with technology because we use technology to store all of our data and to save a lot of stuff and that's part of the course.

Overall, students in embedded analysis 1 believed technologies have an impact and a huge impact on their learning in biology class.

Similar to students in embedded analysis 1, students in embedded analysis 2 believed technologies have also impacted their learning in biology class. Two themes emerged from the data. These themes were connection to learning and understanding, and learning and skills acquisition. Regarding theme one of the connection between learning and understanding, Eva believed that her experiences with technologies allowed her to use technology to communicate with her body. By using technology, Eva indicated that the technology served as a communication device to tell her how her body is doing and the message her body is sending back to the technology allows her to understand her body health and function. Also, with the use of technology, Eva reported a deeper understanding of what she is learning. Eva said "the technologies that we use gives us a deeper understanding of how computers analyze and automatically calculate the things that we need for our lesson." Similarly, Guy indicated deeper understanding with technology use:

> By learning through hands-on and through experiencing with the technologies, I also get a better understanding of what to do and how to do it better. I think, my learning is impacted because I enjoy learning about the content, I'm excited about coming to class, and by doing the experiment then I'm able to understand the materials better than reading about it.

In alignment to understanding, in support of Eva and Guy, Flo suggested that her experience with technologies allowed her to make connections between learning and understanding. Flo added:

> I mean if you think about it, in hospitals there's so much technology that we don't know as high school students but being given these certain technologies to kind of just test and play with, we're able to see that heartbeats are different. I mean when you are up and running after exercising, off course your heartbeat spikes are going to look different compared to when you are you are just resting and breathing normal. It allows us to really understand that the body works in

> different ways and that everything is really intricate and really detail. However, miraculously the body just does everything its self and we don't even really have to focus on it.

Thus, the use of technology has allowed Flo to make connections and better understand how her body functions. In addition, the use of technology provided an insight of how the technology works and what the purpose of the technology is used for in their learning.

While learning and understanding is impacted by technologies, technologies also impact specific skills such as career choice, test prep, and science techniques. In terms of theme 2 of learning and skills acquisition, Henry indicated that the use of technology is fun but it also helps him prepare for the test when he is being assessed on how to conduct an experiment. By doing the experiment, Henry is able to learn, understand, and recall what he did when it is test time. In addition, the lab skills acquired during experiments are transferrable to written exams. Besides test prep, the impact of technology also prepares students with relevant skills for the future and allows them to explore future career. Eva believed that what she learned in class will be useful in the future. Eva stated "it would be really useful if we encounter these programs in the future or something similar to it and that would be helpful with our career if it is somewhat related to these science and mathematics field." Similarly, Guy added:

> The technologies allow me to understand how to use the tools correctly. I'm able to learn using the technologies that scientist and doctors are also using so that is very cool. I also learned the skills and techniques of doing science.

Thus, the experience with technology in the classroom has an impact on relevant skills and techniques that are applicable and transferrable to future career choices. Although technology is impactful toward learning and skills acquisitions, another impact is the motivation to learn. Henry added "I am also motivated when I come to class and see the technologies out because I know it will be a fun class and I will learn how to use a new science tool." Overall, students believed that their experience with technology has both an impact and a huge impact on their learning, understanding, and motivation within their biology class. Students believed that technologies impacted their learning by communicating with their body, connecting learning and understanding, developing deeper understanding, establishing joy and excitement for learning, learning use and purpose of technology, making learning fun and engaging, motivating them to learn, being relevant to future career, supporting test prep, and understanding tools, skills, and techniques of science.

Student interview question 5. The fifth interview question was: What factors do you believe influence your acceptance of technology in biology class? In embedded analysis 1, students believed there are six themes that influenced their acceptance of technology. The themes included relevance and commonality, results make sense, efficiency, usefulness: what technology can do for me, actual use and benefit, importance and interest in the actual use of technology. Theme one of relevance and commonality contributed to Amy's acceptance of technology use. Amy added:

> I think it all comes down to the fact that technology is really relevant, especially for our generations, we grew up with computers and cell phones so when we

come into the classroom, in the biology classes and we have to use technology for that, it is pretty common for us. We do a lot of research so biology courses also deal with research a lot so we use computer for that. That makes accepting technology in biology classes specifically more easily.

Theme two contributed to Beth's acceptance of technology in understanding that the results make sense. Beth accepts the use of technology from her teacher but it is also important for her to make her own meanings from the data she obtained. According to Beth, she believed that the data she collected all makes sense so that is why she accepted technology for getting her the data she needed. In addition, usefulness is another theme that described Beth's acceptance of technology. In terms of theme three, Beth accepted technology for what technology can do for her. Beth explained the usefulness of technology as:

I think it's safe to say that what it is able to do is why I accept it. But sometimes technology is wrong as well so we need to double check things without technology. Other than that, I do think that they help like do things more efficiently and decrease the amount of times it takes to do it.

As Beth realized the usefulness of technology, she also realized that technology is efficient to use to help her accomplish her task in a timely manner. Therefore, efficiency is another theme that influenced Beth's acceptance of technology.

Theme five is actual use and benefit, and contributed to Cora's acceptance of technology. When Cora uses technology to support her learning she sees the benefit of what technology has on her learning and thus it makes her accept technology. Cora added:

> I think the fact that it makes everything clear or everything like when I look under the microscope, it's fascinating, it's just you cannot believe what you see and those kinds of factors that really open your eyes to something that your bare eyes cannot see. Those things make you believe in biology, believe in the thing that everyone else discovered and you come and you get to discover with like on your own self. That kind of things really opens my eyes to accepting technologies because they really do help us see things that we cannot see.

Thus, the actual use of technology allows Cora to make meanings and connections from what she sees with the technology.

In terms of theme 6, the contributing factor to David's acceptance of technology included the importance and interest in the actual use of technology. According to David, he accepts technology if he sees the importance of technology in the class:

> Some factors that influenced my acceptance of the technology is the importance of the technology that I see within the class. For example, we can be doing a lab but then if I don't see the importance of the technology I won't really use it even though I'm instructed to use it.

Although finding a fit for the technology within the course work is important for David, his interest level is also important in deciding if he will accept or reject a technology. David added:

> Also, I believed that how interesting the technology is, is what influenced me because even though sometimes I'm not sure how to use the kind of technology but since it is interesting I will keep going until I know how to use the technology because I'm hooked into it.

Thus, the technology needs to be appealing to David to draw his interest into using it. Overall, all four students have different beliefs in terms of their acceptance of technology.

While students in embedded analysis 1 accepted technology differently, students in embedded analysis 2 are influenced with similar themes for the acceptance of technology in biology class. In embedded analysis 2, the three themes of technology acceptance included ease of use, experience with technology, and usefulness. Regarding theme one, Eva believed that ease of use contributed to her acceptance of technology. Eva added:

> The technology is better and one of the factors that I think why is because it's easy to use, it's really quick, and it also holds all the data so I don't have to go through multiple things just to get it. I can easily connect or print off things that I need or either send it to Google so I can turn it into my teacher.

The second theme as a contributing factor to the acceptance of technology is technology experience. While Eva accepted technology due to ease of use, Henry accepted technology based on his experience with technology. Henry said "my experience with technology is what allows me to accept technology." According to Henry, he feels comfortable using technology if he is knowledgeable in using the technology. Henry added “if I know a little then I’m excited to learn more about it. If I know a lot then I’m excited to show my teacher what I know and how I’ve used it in other classes.”

Even though Eva and Henry have alternative perceptions regarding their acceptance of technology, all four students also shared a common belief regarding the acceptance of technology. As for theme three, all students are influenced by the usefulness of technology in terms of what technology can do for them. For Eva, technology is useful in that:

> I like using Loggerpro because it shows that the graph and all the numbers and the chart over say 5 seconds of when you are breathing or when you are moving. It also does the mathematical calculations so that I don’t have to do it and it won’t take so long. And also, it helps record your results so that you don’t have to do it all over again or lose it anywhere. Yes, one factor that allows me to accept the technology is what the technology can do for me. It can do the calculations for me, it helps record my results so I don’t have to do it all over again.

For Flo, technology is useful because:

> I would say that the fact that it does help me understand the purpose of why we have such technologies made and why we have such technologies made is useful because seeing how it works really allows me to be thankful for actually having it because if not then how will we diagnose something or like how do we know that something is wrong with our body if we don’t have the technology that we have now. And being able to work with them hand in hand allow me to have a better

> understanding of not only what it does but in what circumstances or what cases we can use them for.

For Guy, technology is useful because:

> I also think that the technologies we used in science class is cool and I believe that I can use them to help me learn. My acceptance of technology is what I think the technology can do for me. When we learn using science technology, I think the technology is useful in helping me learn and understand so I like to use it. Even if it is hard to use, I see the benefit of why we are using it because without the technology then we can't measure most of the data that we need to. For example, we can't measure the capacity of our lung with specific units if we can't use a spirometer to help do that for us. Without the technology then we cannot accomplish our assignments so I think that our use of technology in class is to help us finish our experiments or task that was given to use.

Similarly, Henry added that technology is useful because:

> Even if I have little experience, I will still accept technology in biology class because I know it helps us learn and make learning fun. It makes class go by fast and everybody is positive about their learning. I think students are motivated when they get to use technology.

Overall, all students in embedded analysis 2 found technology to be useful in terms of what technology can do for them and this influenced their acceptance of technology. In all, all students in embedded analysis 1 and 2 accepted the use of technology in their biology class.

Student interview question 6. The sixth interview question was: What factors do you believe influence your learning of biology content when you use technology? In embedded analysis 1, there were four themes that influenced students' learning of biology content when using technology. The themes included accessibility of technology for students to do research, increase understanding, create meaningful learning of text to reality, and the use and efficiency of technology. Regarding theme one, access of technology for students to do research, Amy believed technology has made research more accessible for students both in the classroom and outside of the classroom. Amy noted that in the classroom there's a lot of vocabulary and memorization but technology allows her to do more research and go deeper about the content. Amy believed that technology has a positive impact on learning the biology content. The ability to conduct research through technology influenced Amy's learning of biology content. Similar to Amy in conducting research, both Beth and David believed that using technology in experiments has influenced their learning of biology content. In terms of theme two, Beth and David noted that using technology to conduct experiments has helped them understand and learn the content as well as the process of science. David added:

> I believe that the use of technologies has helped me understand the biology content better because I'm able to do experiments and see exactly what we've been taught in class and how that has played out as you do experiments on it.

In addition, David noted that he is able to understand the subject better when he is able to see what he did wrong and what he did right to get to the conclusion. David added "by using technologies to do experiments I'm able to see what steps or what things I have done to get to this conclusion or this step and that has helped me to understand the subject better." While Beth and David believed that technology increases their understanding of science content, Cora also shared similar experiences in which technology helps her understand the content better, but it also creates meaningful learning experiences that relates text to reality. In terms of theme three, Cora believed that the technology they are using is connected to the content they are learning and technology serves as a tool to help them learn. Cora noted that technology really help and brighten what she is learning and make everything zoomed in like a microscope:

> When you see things on your own you can believe it. You can say yes this really happened because in the text or during a lecture you might miss reading a paragraph that can be really confusing when you go on and learn new things. But, when you really see things, it's like right there and you can't really miss it. So that's kind of how it influenced my biology or learning in biology because I really learned every single detail under a microscope, every cell wall and all of that. It really makes learning biology or the parts in biology really clear.

Thus, the use of technology allows Cora to make meaningful connection between text and reality and has influenced her to learn and understand what she cannot see with the bare eye.

As for theme four regarding the use and efficiency of technology, Beth believed technology is helpful in allowing her to do what she needs to do in science class but in a better way. For example, she stated that she can measure her heartbeat by counting her pulse without using a blood pressure cuff, but the use of the blood pressure cuffs is easier and more efficient to measure her heartrate. Also, she can measure her blood pressure accurately and faster using the cuffs. Overall, the use of technology has influenced the learning of biology content for students in embedded analysis 1.

In embedded analysis 2, there are five themes that influenced students learning of biology content with technology. The five themes included attitude toward learning, importance of technology, increase understanding, motivation to learn, and social influence from friends and teachers. Regarding theme one, Eva reported attitude toward learning as an influence for her learning of biology content. Eva believed her attitude toward technology and how she thinks the technology will help her learn is important. According to Eva, if she doesn't know how the spirometer will help her understand lung capacity then the technology has no purpose in helping her learn the content. Thus, when Eva does not understand the purpose of the technology then she develops a negative attitude about the importance of the technology. In regard to theme two of the importance of technology, both Guy and Henry stated that the use and importance of technology is a factor that influenced their learning of biology content. Guy stated that the use of technology or the importance of the use of technology has influenced his learning when he sees the benefit of using technology because he is actually doing the work but the technology is also supporting him with the computerized data collection. Henry added:

> I believe technology is useful and without technology then biology class will be boring and it will be hard for me to learn about biology process and how to do or

> complete a lab. The use of technology is also appropriate for what we are doing in class.

Therefore, the use and importance of technology is a factor that impacted Eva, Guy, and Henry's learning of biology content.

In terms of theme three, as reported by Eva, Flo, and Henry is the use of technology to increase understanding. Eva believed that technology helps her understand the content and is an added feature as a visual to show what the teacher is trying to explain. For example, when the teacher is teaching, Eva can see the visual of the graph and she can see what the data point on the graph means. Flo supported Eva's perception of understanding in that technology helps her develop a deeper understanding of the purpose and use of the technology in the classroom. According to Henry, the use of technology helps him learn and helps him understand the process of how science works. Henry added "I know that I do better when I'm able to understand how the technology we used is connected to what we are learning and they are tools to help us learn." In addition, Henry indicated that technology is useful as it helps him learn and understand the biology content, provides him with more details, and allows him to see what he sees in the textbook.

The fourth theme as reported by Flo and Guy is motivation to learn. Flo indicated that the use of technology encourages her as a student to go deeper with her knowledge of biology because it draws her in and gives her a feeling of wanting to learn more about how something works. Also, Flo is interested in the medical field and she is motivated to learn about biology. She wants to continue to learn more and do more activities using technologies in biology because she believes that the kind of technology she is learning to use is similar to the materials that doctors are using. While Flo is motivated by technology to learn about the medical field, Guy is motivated about using technology because it is not an ordinary tool that he sees every day. Guy added "when I use technology, it makes me motivated to learn and I get excited when I see results that I normally do not see in my learning." Both Flo and Guy noted that the use of technology motivated them to learn biology content.

The fifth theme as reported by Guy and Henry is social influence. Guy noted social influence from his teacher while Henry noted social influence from both friends and teachers. For Henry, the attitude of his friend is a contributing factor. Henry noted that when he sees his friends hold a positive attitude about the technology they are using then he also developed a positive attitude toward technology. Similarly, if his friends see the importance of technology then he sees the importance of technology. Henry believed that if they have a positive attitude about technology and how it can help them learn they may do better too. While peers have an influence on the learning of biology content, teachers also have an impact too. Guy believed that if the teacher holds the belief of using technology to help them with their learning then he also holds the same belief. For example, Guy stated that if my teacher believes that it will help me then I will believe it too. Also, Guy trusted his teacher and believed that if the teacher has a purpose for the class to use technology and if they are to use specific technologies then he believed that the technologies will help them learn and do better in class because it was recommended by the teacher.

On the other hand, Henry believed in the teacher's joy and enthusiasm to use technology rather than what the teacher instructing them to use technology as a factor for learning biology content. Henry indicated that my teacher's joy for technology also makes learning fun and when learning is fun then I want to know more about the topic. Overall, the use of technology has an impact on the students in embedded analysis 2's ability to learn biology content. Table 6 describes the categories that I constructed from my analysis of the interview data.

Table 6

A Summary of Categories Constructed from Student Interview Data Analysis

Interview Question	*Categories*
SIQ1: types of technologies	Computers
	Lab tools
	Medical tools
	Probes and sensors
	Software
SIQ2: are or are not useful	Career exploration
	Easy access to resources
	Hands-on experience
	Important for task completion
	Tools enhance learning and understanding
SIQ3: are or are not easy to use	Computers in general: familiar with
	Specific peripherals: correct technologies
	Specific peripherals: follow instruction
	Specific peripherals: not familiar with
SIQ4: impact on learning	Communicate with body
	Connects learning and understanding
	Deeper understanding
	Enjoy learning and excited
	Increase memory and interest
	Increase understanding
	Learn use and purpose of technology
	Make learning fun and engaging
	Motivated to learn
	Relevant to future career
	Technology is a part of the course to complete task
	Test prep support
	Understand tools, skills and techniques of science
SIQ5: acceptance factors	Actual use and benefit
	Ease of use
	Efficiency: efficient to use
	Experience with technology
	Importance of technology
	Interest in the actual use of technology
	Relevance and commonality
	Results make sense
	Usefulness: what technology can do for me
SIQ6: learning factors	Accessible for students to do research
	Attitude toward learning
	Increase understanding
	Meaningful learning – text to reality
	Motivated to learn
	Social influence from friends
	Social influence of teachers
	Use and efficiency of technology
	Use and importance of technology

Note. SIQ = student interview question

Analysis of Student Reflective Journal Data

Students were asked to respond to four reflective journals questions. The first reflective journal question was: How does the technology that you use in your biology course reflect what you are expected to learn? In embedded analysis 1, all four students have various perspectives of what they are expected to learn. Three themes emerged from the student reflective data. The themes included technology reflects doing research and finding results, technology reflects beliefs in science, and technology reflects independent learning. In terms of theme one, Amy believed that the use of technology in biology course reflects her ability to do research and find results, and to provide feedback and results. Regarding theme one of technology reflects doing research and finding results, Amy believed that computers are useful in biology courses to help students learn what is expected due to its' easy access to research and to store data and results. In addition, Amy support the use of technology to provide feedback and results. Amy noted:

> Technology plays a huge role in widening the opportunities and challenges for biology courses, and computers do this by enabling quick feedback and results. Ultimately in biology courses, it is the feedback and results that reflects what we are expected to learn.

Thus, the use of technology reflects feedback and results. Similar to Amy, Beth believed that the technology she used in biology course reflected what she was expected to learn because she needed to use these technologies to find her answers and to create results. Beth noted:

> If I made a mistake somewhere, my answers would not agree with my peers, or I would not understand it. If I followed the directions and used the technology provided correctly, then I would get answers that make sense and agree with the given answers, thus reflecting what I was expected to learn.

Thus, both Amy and Beth believed that the use of technology reflected what they are expected to learn in providing them with the results they need.

On the other hand, regarding theme two of technology reflects belief in science, Cora indicated that technology makes sure that whatever you learn in the textbook and through lecture is true. Therefore, according to Cora, technology not only teach students but makes them believe in what was being taught. Cora noted "technology act like a proof to show students that certain things do happen even though you don't see with your bare eyes." In a different perspective than Cora, David believed that technology reflect independent learning and new learning. Regarding theme three of technology reflect independent learning, David believed that the technologies he used has reflected what he is expected to learn due to the difficulty of it. David stated, "When using a technology that is hard to use yet I have to operate on it, it shows that I can be expected to learn on my own for most of the course." In addition, when David is expected to learn on his own, his unfamiliarity with the technology indicate that he will be learning something new within the course. David strongly believed that by being able to use the technology, he was able to prepare himself of what the course had to offered. Overall, although all four students have different beliefs regarding their own technology use, they all believed that the technologies they have used reflect what they are expected to learn in biology course.

In embedded analysis 2, all four students shared similar beliefs about how technology reflects what they are expected to learn. The two themes which emerged from the reflective journal data of students in embedded analysis 2 included technology reflects learning and understanding, and technology reflects doing research and finding results. All four students believed that technology reflects learning and understanding while two students believed that technology reflect doing research and finding results. Regarding theme one of technology reflects learning and understanding, in terms of learning, both Guy and Henry indicated that the use of technologies allow them to learn more about what they are expected to learn. For Guy, the use of technology teaches him the skills he is expected to know. Thus, by using technology, he learned how to use it properly to support his work. Guy noted:

> In learning about bones, we used calipers to measure the inside width and the outside width of bones. The caliper measurements and tape measure measurements help us determine specific information about gender, race, age or the height of a person. Other measurement technology such as micropipettor teach us the expectation of how to measure and transfer small amount of liquid accurately. The use of DNA fingerprinting and gel electrophoresis along with centrifuge teach us how to separate DNA and identify unknown people from DNA samples.

Similarly, Henry added that they will not be able to learn about certain biology content if they did not learn how to use the technologies to support their learning. According to Henry, the measurement technologies allow him to measure for specific unit of measurement that deals with heartrate, pulse, lung volume, muscle reflexes, muscle fatigue, energy, and lung capacity. Thus, Henry noted "without measurement technologies such as EKG electrodes, spirometer, and oxygen sensors we cannot measure our lung volume, muscle reflexes, and muscle contraction." Regarding technology reflects learning and understanding, in terms of understanding, Eva believed the technology she used reflects how she should understand the material she is learning and why. Eva noted:

> If we are doing a lab on heart rates, the computer program will show us our resting heart rate on the graph which is a visual of the t-waves and the other parts. By understanding what each part means, we can calculate how many beats per minute our heart beats and ascertain its healthiness. That goes for the other things we do in class for patients that are assigned to us to diagnose.

Similarly, Flo stated that the use of technology allows her to understand why medical technology has been created to help doctors perform their jobs. According to Flo, the technologies she used, allows her to process how the human body functions and to understand how medical technology support doctors in assisting patients. Overall, the use of technology in biology course reflects what the students are expected to learn, be able to do, and understand scientific content.

While technology reflected learning and understanding for all four students, it also reflected research and results for Guy and Henry. In terms of theme two, both Guy and Henry believed that since they are expected to learn everything about the human body, from systems to memorizing anatomical regions and regions of the brain then the technologies they have used has helped them conduct research and find answers to their questions given by their teachers. Guy added:

> In each lesson, we are expected to do research and answer essential questions. Our teacher does not provide us with the answer but we are to use reliable sources to find the answer. The technology that allows us to complete our lesson included laptop and desktop computers and the internet.

Therefore, they indicated that they are expected to complete graphic organizers and diagrams of the human body system. Without computers and the internet then they will not be able to learn about the human body system, complete a diagram, create a presentation, and present their presentation to the entire class. In addition, Guy stated that students are expected to learn about the system and anatomical names, research the function and purpose then build the system out of clay on their manikin. Therefore, through research on the internet using computers, they are able to learn about the names of all the bones in the human body, the anatomical regions, the function and regions of the brain, the importance of food, oxygen and water in the human body; and joints, bones, and muscles. Overall, the use of technology reflects what students are expected to learn in biology course and act as a tool or resource for students to acquire the necessary results to their expected learning. In all, the technologies used by both students in embedded analysis 1 and embedded analysis 2 reflect what all students are expected to learn in biology course.

The second reflective journal question was: How does the technology that you use in your biology course fit the task requirements for the content you are expected to learn? In embedded analysis 1, all four students shared similar and different beliefs regarding the use of technology as a fit for both task requirements and expected content learning. Three themes were derived regarding three task-fit and expected content learning. The themes included extension of learning for better understanding of content, extension of learning from textbook to experiment, and to test and acquire data or results. Regarding theme one, David believed the technology he used to learn about heartbeat and different types of pressure was a fit for his required task in the class because it enables him to do what he needed to do and to get a better understanding of heartrate. Thus, David believed the technology he used fit the task requirement since the technology served as an extension of his learning for better understanding of the course content. Similarly, in terms of theme two, Beth believed that technology is a fit for the biology course as it is an extension of learning from what they learned in the textbook to what they learned in lab experiments. Beth added:

> The technology that I used in my biology course fit the task requirements for the content I was expected to learn because rather than it being something as basic as a textbook, the technology I used was a simulation of textbook knowledge in action. For example, rather than reading about how to measure blood pressure

> with a blood pressure cuff, we used a real blood pressure cuff do what the textbook teaches us.

While some students believed technology is an extension to content understanding and learning in biology course, other students believed the technology used in biology course is a TTF due to the ability to test and acquire data or results. In terms of theme three, both Amy and Cora believed the technology they used in class is a fit to the course requirement. Amy indicated that she used specific technology that correlates with what she is learning in class. For example, Amy indicated she used technologies connected to a laptop to test her heartrates to learn about the human body. According to Amy, the use of technology has allowed her to see how each technology works and how technology plays a role in acquiring results for her and her classmates. In addition, Cora support technology as a task fit for acquiring results and indicated that technologies are useful in labs to collect data. Cora noted:

> Most technologies we used during a lab to collect data is a technology fit because to learn about something in depth, students must find the solution to their questions and to prove that they must find the data that can answer their question. Technology is the aid to that. It didn't tell students the content but allow students to find the answer which make learning much more exciting and understandable.

Overall, all four students in embedded analysis 1 believed that technology is a task fit for what they are expected to learn.

In embedded analysis 2, the three themes for technology task fit included extension of learning for better understanding of content and to acquire data or result.

Eva believed technology is a task fit for the extension of learning for better understanding of content while Flo, Guy, and Henry believed technology is a task fit to test and to acquire data or results. Regarding theme one, for Eva, the technology she used fits the task requirement of the content she is expected to learn because the technology she used makes it easier for her to understand the content. Eva believed technology makes it easier for her to understand the content because it provided her with diagrams to explain what the teacher is instructing. While the use of technology provided a deeper understanding for Eva, it also made learning meaningful since she is actively participating in the data collection process. Eva noted:

> Without technology, we would not have a deeper understanding of the material and instead it would be superficial. Also, integrating technology into the classroom means the things we learn are more meaningful since some of the data we record and receive are from ourselves while other ones are from made up patients.

Thus, Eva believed that technology is a task fit since it contributed to her better understanding of course content.

Although the task fit of technology is different for Eva and the other three students, Flo, Guy, and Henry also believed that the technology they used in biology course fit the work they are doing. In terms of theme two, the use of technology allowed Flo, Guy, and Henry to test and acquire data and results for the task requirements they are expected to do. Flo indicated that the content they are expected to learn in class was to see how technology works to assist doctors perform their jobs and the technology they used is a fit for the course requirements because it helped them see how it works. Also, Flow stated that the technology used in the class allowed for students to do more research regarding topics covered in class. Similarly, Guy believed that they are expected to learn about reflexes, grip strengths, breathing rate, heartrate, lung volume, and lung capacity; and the use of technology if a fit for them to learn about these topics. As noted by Guy:

> The use of EKG electrode helps us measure reflexes in the human body. The use of the dynamometer helps us measure grip strengths. The use of spirometer and oxygen sensors help us measure breathing rate, heartrate, lung volume, and lung capacity.

Thus, technology is a task-fit for the content students are expected to learn and allows them to use technology for data collection. In addition, Henry supported both Flo and Guy in the use of technology as a task fit for data collection. According to Henry, they are given case studies to evaluate and identify the cause of a disease, to identify symptoms to a sickness, or to diagnose a patient's sickness based on background information and symptoms. Thus, when this happens, they are expected to learn about the causes, symptoms, and disease through research on the internet. Henry added:

> The use of computer to do research fits the task requirement that our teacher asked us to complete. Other times we are asked to use gel electrophoresis to identify a missing person or to learn about DNA separation. The use of gel electrophoresis teaches us the process of DNA extraction and separation, and teaches us gel analysis of DNA samples. When we learned about muscle contraction, we are expected to learn how hard the muscle is working in our body.

> We are able to use EKG electrodes and exercise to help us measure muscle relaxation, contraction, and fatigue.

Overall, the use of technology is a task fit for all students in embedded analysis 1 and embedded analysis 2 to support learning, understanding, lab technique and skill acquisitions, and completion of expected course requirements.

The third reflective journal question was: What social influences do you believe reflect your beliefs about the usefulness of technology for this biology course? In embedded analysis 1, all four students developed various social influences regarding the usefulness of technology in biology. In terms of social influences, the four themes included societal functions, trial and error, first-hand experience and exposure to science, and lack of technologies in the home. Regarding theme one of societal functions, Amy believed that technology is constantly evolving in businesses and with it comes more opportunities for technology in education. The exposure to technology where technology is a huge part of how the world runs today contributed to Amy's belief. Amy added:

> I believed that this acceptance and beliefs of usefulness in biology courses greatly stems from how technology has been so useful already in other purposes other than in education. For example, how the majority of people get their news here in the United States is not through newspapers anymore, but through televised news stations, radio stations, and news websites. People also mainly connect using technology by texting and/or websites such as Facebook. It is not difficult to not doubt technology in biology courses when technology has become such a normal part of how society functions.

While Amy believed the usefulness of technology is influenced by society functions, Beth believed the concept of trial and error is another social influence. In terms of theme two, Beth believed that trial and error reflects her beliefs about the usefulness of technology because if students mess up on an assignment then they will learn from it and do things differently. In other words, Beth stated that "if we do something wrong, we learn from that, and we should not repeat the same mistakes."

As for Cora, the social influence that influence the usefulness of technology is first-hand experience and exposure to science. Regarding theme three of first-hand experiences, Cora indicated that her home-life experience has an influence on her school experience and the events she experienced at school served as exposure to science learning. Cora noted:

> As a Hmong student, I grew up in a family that does not believe in science. We believe in spirit and never believe in how the human bodies or other living things were formed and how they were related. First time learning about it in class can make it hard to believe and it will be hard to believe whatever was said by the teacher and reading text books because there are times when we don't understand what the book are saying or what the teacher is trying to explain. But with technology and the language of showing instead of telling, we understand things better. When reading, we might not understand what cells are, but under the microscope we get to see what cells are like and learn that way. This is why technology is so useful for students like us.

For Cora, technology is useful in supporting her scientific understanding by showing or exposing her to science opportunities' that she may not experience or understand at home. Similarly, the difference in home and school life is also an influence for David regarding the usefulness of technology. In terms of theme four, for David, it is a lack of technology in the home rather than the lack of scientific exposure that influenced the usefulness of technology in biology class. David believed that technology was not helpful since most of his learning was done by himself without the use of technology. David indicated that he grew up around his parents and family and this impacted his beliefs on the usefulness of technology since his parents were of the older generation who did not use technology at home. According to David, since they did not have technologies at home, he did not see the usefulness of technology. However, the introduction of technology at school allowed David to believe that technologies can really help him get a better understanding of what he is trying to learn. Overall, the usefulness of technology in biology is influenced by social factors for all four students.

In embedded analysis 2, the students also shared similar social influences that students in embedded analysis 1 experienced. The five themes supporting social influences included societal functions, media and learning environment, first-hand experience and exposure to science, attitude toward technology, and support system. Regarding theme one of societal functions, Eva believed that socially, technology plays a big part in our lives so it is acceptable to use it in the classroom. She also believed that it is better to learn how to use technology in high school biology course than when she is in college or on the job training. Eva believed that technology is fast and easily accessible so this makes it favorable and useful. Eva added "society makes use of technology in biomedical fields, so it is beneficial to build up an early experience of using different programs as a benefit to your future if you're planning to go in those fields." Therefore, technology is useful because it is part of societal functions. In terms of the second theme of media and learning environment, Flo believed that media portrayal of the success of medical interventions has positively shadowed her belief that technology is useful in biology class. Thus, her belief of the usefulness of technology is influenced by the media.

First-hand experience and exposure to science is the third theme derived from social influence and is shared by both Flo and Henry. Flo noted:

> I've seen what technology can do to improve one's quality of life and in this course, I was able to get first-hand experience of how intricate and important everything is when setting up, analyzing, and collecting data when the technology is in use.

Thus, Flo's experience with technology allows her to determine that technology is useful based on what it can do for her. In addition, Henry also saw the usefulness of technology when he was exposed to it. According to Henry, without the use of science technology, students will not be able to collect data for our experiments such as he does not know how he can measure the time of muscle reflexes without the use of sensors and probes.

In terms of theme four for attitude toward technology, both Guy and Henry believed that peer pressure is a social influence to the usefulness of technology in their classroom. They believed that their friends' attitude in class affects how they feel about the usefulness of a particular technology. Henry stated that he doesn't know how he can use the technology if his teachers and friends did not have a positive influence in showing him how to use it. Similarly, Guy added:

> Sometimes my friends think the technology is too hard so they make me feel like I can't do the experiment. Other times, my friends don't know the purpose of doing an experiment with technology so they think it is not useful to what we are doing in class.

The fifth social influence theme is support system as explained by Henry. Henry believed that the support he receives from his teacher and classroom affects the usefulness of technology. According to Henry, the teaching he receives from his teacher and peers encourages him to use technology in the classroom. Henry stated:

> I think the classroom environment and the support I get from my teacher and peers play a big role in my use of technology. Even when I don't know how to use a technology, my teacher and friends are able to teach and show me how the technology is important and useful in completing our assignment.

Overall, the usefulness of technology in biology is influenced by social factors for all students in embedded analysis 1 and embedded analysis 2.

The fourth reflective journal question was: What personal factors do you believe influence your beliefs about the usefulness of technology in this biology course? In embedded analysis 1, six themes emerged in support the usefulness of technology in terms of personal factors. The six themes included experience of learners and technology maturity of the user, learner's engagement, learning style as a visual learner, learning style as a hands-on learner, performance – easy to understand content, and positive technology use. The first theme for personal factor is experience of learners and technology maturity of the user. Amy believed she grew up in a time where cell phones and computers were up and coming. The accessibility to technology and her knowledge of using it made it easy for her to use technology. Amy stated that her experience and understanding of technology played a significant role in how she viewed the usefulness of technology. The second theme for personal factor is learner's engagement. Beth believed that her interest level in the content of the biology course was due to the use of different technologies in her learning. Beth noted:

> I remained interested in the content of the biology course because of how the curriculum and lessons were set up as well as how different technologies were incorporated to play out with the story line created by the course. I really enjoyed how the technology allowed us to act as if we were doctors and medical professionals looking for answers.

Beth found technology useful in teaching her the skills of medical professionals. The third theme for personal factor is learning style as a visual learner. Amy believed that technology is essential in biology courses to serve as a bridge in students' understanding between the research aspect and the results aspect. As a visual learner, Amy believed technology is a great tool for biology learning. Amy indicated:

> I need to see how things work in order to be able to fully grasp my understanding on the concept, and technology can serve as what shows me how it works. Especially in biology courses where students have to deal with experiments and

> research, technology with its advances and constant improvements can provide as a great tool.

Therefore, being a visual learner influenced Amy's belief about the usefulness of technology in her biology course.

While Amy is a visual learner, Beth is a hands-on learner. Thus, the fourth theme for personal factor is learning style as a hands-on learner. Beth believed that the ability to feel and use technology in the learning of biology content is what influenced her beliefs about the usefulness of technology. According to Beth, when she is able to do and use technology then she is able to remember what she learned. The fifth theme for personal factor is performance – easy to understand content. Cora believed that technology makes biology class easier for every student to understand things better. In addition, Cora stated that seeing the evolution of technology and how much easier it is to obtain information from all types of technology makes her believe in the usefulness of technology. Cora added:

> It was hard to imagine what gel electrophoresis is because we never have the materials to make the gel and the magnetic field to pull the DNA, or even have the DNA to test, but now it is so easy. We get to prepare the gel, put the DNA in and really see the magic happen.

Therefore, the ability to use technology to bring out the learning of science is what Cora believed to influence her belief about the usefulness of technology in her biology course. Lastly, the sixth theme for personal factor is positive technology use. David indicated that he had a positive experience with technology use. David was taught growing up that technology can do more good than harm to him. Therefore, David's positive experience with technology played a big factor in determining whether a technology was useful or not. David noted:

> Since I was taught that technologies are beneficial, I would also look at the bright side and see how technology has been able to help me throughout the course. As a result of this, I didn't not see any negativity within the use of technology. Instead, I was only able to see how it helped me get a better understanding of what I was learning or doing.

For all four students, although they hold different beliefs of factors that influenced their usefulness of technology, they all shared the idea that technology was useful in their biology class.

In embedded analysis 2, there are five themes for personal factors that influence the usefulness of technology. The themes included positive technology, confidence and learning experiences, cultural experiences relevancy, increase performance, and learner's engagement. The first theme for personal factor is positive technology use. Eva believed that technology is useful because she lives in a time period where technological advances have become more efficient and allowed her to calculate complex numbers and problems in a shorter amount of time. According to Eva, technology is useful since it saves time, it is easy to use, it makes the concepts they learned in class easier, and it enhances the materials they learn in class. The second theme for personal factor is confidence and learning experiences. Guy believed that his confidence in using the technology is important and plays a role in the usefulness of the technology. According to Guy, if he has a good experience using the technology then it is useful to his learning. On the other hand, even if he had a bad experience, if he is able to learn what he is supposed to then technology is also useful to his learning.

As the learning experience of technology is important or Guy, the cultural experiences and relevancy of technology is important for Flo and Henry. The third personal factor theme is cultural experiences relevancy. Flo and Henry believed that their culture influenced their beliefs about the usefulness of technology. For Flo, the cultural relevance of what she experienced at home with her family and then learning about biological concepts at school with medical technology influenced the usefulness of technology. Flo stated that having family members who have health conditions in which she learned about in class and being able to see how medical technology is used to help patients with such condition is what influenced her belief about the usefulness of technology. For Henry, the opportunity to experience something he does not get to experience at home is what influenced the usefulness of technology. Henry added:

> I don't see a lot of these technologies when I go home or get to use them at home because we don't have them so when I come to school and see new technologies, it is like a new toy and I want to keep playing with it. Sometimes I wish I can take the sensors and probes home and do the activities with my parents and sisters because it is so cool.

Therefore, both Flo and Henry believed that cultural experiences and relevancy is a personal factor that influenced their belief of technology usefulness. Furthermore, the fourth personal factor theme is increase performance. Guy believed that technology is useful because it helps him learn. Guy stated "the usefulness of technology for me is how the technology helps me learn and the benefit it can do for my learning. If a technology can help me learn or do better than it is useful for me." Lastly, the fifth personal factor theme is learner's engagement. Henry believed that his excitement and engagement in the use of technology is why he thinks technology is useful. Henry indicated that although he may not know how to use the technology, he was always eager to learn and be engaged in all activities. Therefore, Henry stated that his participation in the activities using the technologies create a positive experience for him in the end. Overall, all students in embedded analysis 2 believed technology is useful in their classroom.

In comparing the responses of the two embedded analysis groups, all eight students shared similar and different beliefs and are influenced by various experiences relating to what they are expected to learn, task fit, social factors, and personal factors. Students are expected to learn the same biology content but hold various beliefs regarding the use of technology, and are influenced by both social and personal factors. Table 7 describes the categories that I constructed from my analysis of the student reflective journal data.

Table 7

A Summary of Categories Constructed from Student Reflection Journal Data Analysis

Reflective Journal Question	*Categories*
SRJQ1: expected to learn	Technology reflect belief in science
	Technology reflect learning and understanding
	Technology reflect doing research and finding results
	Technology reflect feedback and results
	Technology reflect independent learning
	Technology reflect finding answers and results
	Technology reflect new learning
SRJQ2: task fit	Extension of learning for better understanding of content
	Extension of learning from textbook to experiment
	To test and acquire data or results
SRJQ3: social factors	Attitude toward technology
	First-hand experience and exposure to science
	Lack of technologies in home
	Media and learning environment
	Part of societal functions
	Support systems
	Trial and error
SRJQ4: personal factors	Confidence and learning experiences
	Cultural experiences relevancy
	Experience of learners and technology maturity of the user
	Increase performance
	Learner's engagement
	Learning style – visual learner
	Learning style – hands-on
	Performance – easy to understand content
	Positive technology use

Note: SRJQ = *student reflective journal question*

Analysis of Interview Data: Teacher Perception

Teachers were asked to respond to six interview questions to determine how high school biology teachers perceive the usefulness and ease-of-use of technology innovations for Hmong students in their courses. The first interview question was: What technologies do you use in your biology course? For embedded analysis 1, Mr. Adams reported using computers, probes and sensors, and software. Regarding computers, Mr. Adams indicated that they used Google classroom and Google drive via laptop computers and desktop computers. In addition, they also used tablets. As for probes and sensors, Mr. Adams said they used spirometers for the breathing exercise and anything that is connected to the LoggerPro. Thus, Mr. Adams stated that they used the software LoggerPro. Similarly, in embedded analysis 2, Mr. Banks also reported using computers, probes and sensors, and software. In addition, Mr. Banks reported the use of web service. Mr. Banks indicated that he used computers in his class to operate the Google classroom web service to post assignments and for students to turn in their assignments. The use of probes and sensors as described by Mr. Banks is associated with Vernier probes. Mr. Banks added:

> We used Vernier probes, it used to be LabView as the computer program but it has been LoggerPro. We used those probes to test heartrate, blood pressure, EKG, EMG for muscle contraction, reflexes. We also used it for surface temperature, respiration rate, lung volume, oxygen capture, and lots of those labs that we used with Vernier.

Since the Vernier probes required LoggerPro as a software, software is another type of technology used in Mr. Banks' classroom. Another software used by Mr. Banks is Inspiration. Inspiration is a concept map builder program that allows students to create maps. Other than computers, probes and sensors, and software, lab tools are also a type of technology used significantly by Mr. Banks. Mr. Banks added:

> I also considered microscopes as technology, I would think; use that to look at bacterial, histology, and cancer. We also used things like the water bath, thermo

> cycler, centrifuge, you know scales and mixers and the basic thing that you think of.

Overall, the types of technologies used by both Mr. Adams and Mr. Banks included computers, lab tools, probes and sensors, and software.

The second interview question was: Why do you believe that these technologies are or are not useful? For embedded analysis 1, Mr. Adams believed technology is useful because it is relevant and relatable to science professionals. Mr. Adams noted:

> This technology is useful because it is basically the same kind of technology, especially for PLTW courses, it is the same technology as some of the people in the field would be using. So for our kids to be using the same things as somebody who is a doctor or somebody who is an engineer, it relates to the students better.

As for embedded analysis 2, Mr. Banks believed technology is also useful in terms of conducting high level labs, increasing exposure to technical science, intentional use of technology, and preparing students for college labs. Mr. Banks stated that technologies are useful because “we couldn’t be able to accomplish as many high-level labs without them.” Mr. Banks added “for example, like oxygen capture, without the technology there’s no way we could do that type of lab in a high school setting.”. Furthermore, Mr. Banks believed that technologies are useful because he thinks technology increases the exposure of students to higher technical science. In addition, Mr. Banks believed technology is useful if it is used intentionally with a purpose and is valid for work that needs to be done. According to Mr. Banks, if technology is not purposeful and valid then it is not useful. Mr. Banks added “I want to make sure that the technology I am using is valid, is useful. Having technology for the sake of technology is not helpful, it has to be intentionally used with a purpose that is intended." Another reason why technology is useful for Mr. Banks is the preparation of students for college level labs. As noted by Mr. Banks:

> I also think it preps them for more advanced sciences. For example, in college labs they will have to use more complex technologies and being exposed to it in high school they will be more prepared to use them like a micropipetitor.

Overall, both Mr. Adams and Mr. Banks believed that technology is useful in their classroom.

The third interview question was: Why do you believe these technologies are or are not easy to use? Both Mr. Adams and Mr. Banks believed technology is easy to use but in different ways. Mr. Adams believed that instructional resources support specific technology usage in the classroom. Mr. Adams indicated:

> Well the technology is easy to use because PLTW has actually provided some of the instructions and manuals for us to use. So it's easy to use and then they also have like instructional videos for you to go through as well. And then there's teachers and there's students who put out YouTube videos on how to use the equipment. So, access to resources makes it very easy to use. And then for the science classrooms, if you purchase a kit, there's always a manual for you to use along with videos as well.

On the other hand, Mr. Banks believed that technology is easy to use but it takes time to adapt and learn as well as to train students to use it properly. Mr. Banks noted:

> My experience with technology enables me to probably adapt and learn better but instructing students on that, it's, there's a big learning curve on some of those technologies. And so, it sometimes can take away from the instruction of what you are trying to accomplish using them and you are more or less training them to use it in the first place.

Overall, technologies are easy to use because they have the resources to teach, adapt, and train themselves as well as their students.

The fourth interview question was: How have your experiences with these technologies impacted Hmong student learning in biology classes? Mr. Adams believed technologies have impacted Hmong student learning due to limited exposure and experience to technology, and technology integration and actual use of technology. Regarding limited exposure and experiences, Mr. Adams stated that students do not go outside of their community or outside of their school and do not have opportunities to use the technology or equipment that other people use. Mr. Adams also stated that at home, basically all the technology they have is just a computer, phone, or tablet so they do not have the experience of using other types of technology. Thus, the limited exposure and experience has impacted Hmong students learning in biology classes. In addition, Mr. Adams believed technology integration and actual use of technology is important for Hmong students. According to Mr. Adams, for Hmong students, a lot of hands-on is helpful for them to learn biology concepts. Mr. Adams noted:

> At times they get overwhelmed with some of the content but for them to actually use the equipment and apply that, it's very helpful for students. They are so use

> to sitting in the classroom in that lecture and then not getting to use equipment using their hands.

Therefore, the use of technology has impacted Hmong student learning by allowing them to experience and use technology to support their learning.

For embedded analysis 2, Mr. Banks believed technologies impacted Hmong student learning due to excitement to pursue health career and skills relevant to life. Mr. Banks believed the use of technologies in the classroom creates excitement for students. Mr. Banks stated “I think that it excites the students in biomed to pursue careers in the health career as we see more and more education in the Hmong community.” In addition, Mr. Banks believed Hmong students are impacted by the technologies they used in class because the skills they acquired in class is relevant and relatable to their home life. Mr. Banks added:

> Well I think in far as blood pressure goes, learning that is really key because they can take that home and basically know they need to test their blood pressure because it is a huge indication of health. So, they are able to take that home and possibly even teach their family how to do it because it is fairly simple. And not just how to do it but the fact that hypertension is so such a growing concern in the Hmong population that just having the education is important to test what is high, what is low, and what is normal; then they can be more informed of their own health as well as their family.

Overall, Mr. Banks believed the use of technologies have impacted Hmong student learning in biology classes.

The fifth interview question was: What factors do you believe influence Hmong student acceptance of technology in biology classes? In embedded analysis 1, Mr. Adams believed the factor that influence Hmong student acceptance of technology in biology classes is familiarity with technology. Mr. Adams believed that if students are not exposed to technology at home then they are unfamiliar with the technology and will be resistant to the use of the technology. Mr. Adams added:

> One factor I think is the fact that parents have never been using or they are not use to using all this technology. Maybe using a phone and a computer but that's about it. The fact that students have not or they have or don't know anybody that has used the equipment or has an idea of what to do with the equipment can affect their ability to just like or I would say go out of their way to actually approach and use the equipment.

Therefore, according to Mr. Adams, familiarity with technology can have a positive or negative effect on students' acceptance of technology use.

On the other hand, Mr. Banks believed that the two factors that influenced Hmong students' acceptance of technology included compliance and willingness to learn. Regarding Hmong students being compliant and no cultural objections, Mr. Banks believed Hmong students will do anything he asked them to do. Mr. Banks noted:

> I think they're (Hmong students) so compliant that they just go along with what you are saying and teaching that and they do it anyway whether or not they accept it or not I suppose. I never had anybody object to using technology. They may object to why are we doing this but that's more or less of childish and not of any

> cultural objection. I never had any problems with that. I never had even issues when we go to the Medical College and seen their cadaver lab. I mean there's some aversion as to the yuck factor but I've never had any cultural objections.

Therefore, Mr. Banks believed there's no cultural objection to Hmong students' acceptance of technology and they are willing and ready to learn anything. Overall, technology familiarity and compliance and willingness to learn support Hmong students' acceptance of technology use in biology classes.

The sixth interview question was: What factors do you believe influence Hmong student learning of biology content when they use technology to assist them? Mr. Adams believed the factors that influence Hmong student learning of biology content with technology included engagement and relevancy to life and career. According to Mr. Adams, if the technology is not engaging, then students will not be engaged and that may have a negative impact on student learning. Mr. Adams noted:

> An example is PowerPoint, PowerPoint is technology but if it is just a boring PowerPoint, it is not engaging. After a while, kids, students don't appreciate that.

Therefore, the intentional use of technology is important for the learning of biology content. In addition, Mr. Adams stated that if the use of technology to learn about biology content is not related to life and career then students may not want to learn about the technology and the biology content. Mr. Adams said if you use technology just for busy work then students start to not like the fact that you are using technology in the classroom. Therefore, the use of technology needs to be intentional to support student learning.

On the other hand, Mr. Banks believed the factors that influence Hmong student learning of biology content with technology included outdated resources, increase understanding, and intentional use of technology. Mr. Banks believed the use of outdated technology may influence student learning as the technology may not be purposeful or relevant to what they are learning. Mr. Banks added:

> It's annoying too because then technology is replaced and then you have old technology you don't know what to do with, can't use it anymore or it's not purposeful anymore and you have to buy the new stuff. So, it can be expensive that way.

In a way, if it is expensive to purchase current technology, then insufficient funding to purchase new technology may affect student learning. However, with the right technology, Mr. Banks believed that technology can influence student learning. Mr. Banks believed the use of technology increases student understanding of biology content. Mr. Banks noted:

> I also think that having those experiences increase their ability to understand content because then they have the language to connect the experience and that's just basic ESL strategy anyway. To have that experience, that background experience in order to connect the language to that. So, when you are teaching them the language that is so abstract and then when you can connect that with an experience or technology or the process of using the technology that language becomes a whole lot more meaningful and less abstract and more concrete.

In addition, Mr. Banks believed that the intentional use of technology is another factor to support the learning of biology content. Mr. Banks added:

> I think with technology like I said, you have to be intentional. You can't just spend money and expect kids to learn. It has to be driven with an objective. It has to be for a purpose. It's not for fun; it's a learning thing. So you have to have a reason or objective. And so when teachers are asking for a particular technology, it's not because they just want to have cool toys, it's they have an objective they're trying to meet with it. And then also sometimes things can be donated and we're like but I'm not going to be able to use this. So it has to be really intentional.

Overall, both Mr. Adams and Mr. Banks believed the use of technology can influence Hmong students learning of biology content. Table 8 describes the categories that I constructed from my analysis of the interview data.

Table 8

A Summary of Categories Constructed from Teacher Interview Data Analysis

Interview Question	*Categories*
TIQ1: types of technologies	Computers
	Lab Tools
	Probes and Sensors
	Software
	Web service
TIQ2: are or are not useful	Conduct high level labs
	Increase exposure to technical science
	Intentional use of technology, purposeful and valid
	Preparation for college labs
	Relevant and relatable to science professionals
TIQ3: are or are not easy to use	Specific peripherals: instructional resources support usage
	Specific peripherals: adapt and learn
	Specific peripherals: takes time to train students
TIQ4: impact on learning	Excitement to pursue health career
	Limited exposure and experience to technology
	Skills relevant to life
	Technology integration and actual use of technology
TIQ5: acceptance factors	Compliant and no cultural objections
	Willingness to learn
	Familiarity with technology
TIQ6: learning factors	Not engaging
	Not relevant to life and career
	Outdated resources
	Increase understanding
	Intentional use of technology
	Relevant to life and career

Note. TIQ = student interview question

Analysis of Teacher Reflective Journal Data

Teachers were asked to respond to four reflective journals questions. The first reflective journal question was: How does the technology that you use in your biology course reflect your expectations for student outcomes? Due to the technologies used in the classroom, Mr. Adams expects students to become resourceful individuals while Mr. Banks expects students to become proficient users of technology. Mr. Adams expressed his expectations for student outcomes as:

> I expect my students to become more resourceful individuals. I have used the internet to show interactive websites, videos, programs and applications that students can access for clarification on science topics. Therefore, when students are assigned projects, presentations, labs, or research papers, students do not rely entirely on me for information or assistance. In addition, students should be able to cite information that is current and relatable to their classmates.

Therefore, in Mr. Adams' classroom, students are expected to use technology to become independent learners and to use technology to support their learning. On the other hand, Mr. Banks expects students to be able to use technology with a degree of proficiency. Mr. Banks added:

> I expect my students to be able to proficiently use technology for both collection and analysis of data. They must be able to set up and run programs like LoggerPro as well as use basic laboratory appliances like an incubator, centrifuge, microscope, micropipetter, etc. They need to be able to run programs like Microsoft Word, PowerPoint, Excel, as well as their Google counterparts. They also have to be skilled in doing internet queries and evaluating information found on the Web.

Therefore, students are expected to be able to use technology to accomplish a task. Overall, both Mr. Adams and Mr. Banks expect their students to be able to use technology to fulfill the course objectives. In other words, they want students to be skillful in the use of technology to access resources, cite resources, set up programs and experiments, and evaluate resources.

The second reflective journal question was: How does the technology that you use in your biology course fit the task requirements of the content you are expected to teach? Both Mr. Adams and Mr. Banks believed the technology they have used in their biology course fit the task requirements because the technology supports teaching and learning. According to Mr. Adams, technology helps support his teaching of science topics to students of all learning abilities. Mr. Adams explained how the use of virtual labs and YouTube videos support teaching and learning. Regarding virtual labs, Mr. Adams noted:

> Visual and kinesthetic learners are supported through virtual labs. I have used virtual labs to introduce new content, supplement class labs and lectures, and expose students to lab equipment that the school does not provide due to the financial cost of the equipment. Rather than just speaking about lab equipment that science professionals have encountered, students are able to interact virtually with the same lab equipment. The equipment and procedures that the students visualize or engage with help students to retain content as well as allow students to dive deeper into the content.

Thus, technology is a fit to teach new content to students and for students to retain the content. In addition, Mr. Adams believed that YouTube videos created by science teachers and science professionals included step by step procedures to support data collection, calculations, and analysis. Mr. Adams added:

> These videos help visual and auditory learners in my classroom. While watching these videos during classroom instruction or as homework, students can pause the

> video or go back to certain time intervals for clarification. Also, referencing interesting and engaging videos during discussion or lecture helps students recall information.

Similar to the use of virtual labs, the use of YouTube videos fit the task requirement of the content because it supports students to recall content information.

Similarly, Mr. Banks also believed that technology is a fit because it supports teaching and learning. Mr. Banks believed that the technologies he used in his class fits his class content well. As noted by Mr. Banks:

> The technology I use fits my class content well. Students are supposed to run PCR, restriction enzymes, gel electrophoresis, incubate bacterial samples, view microscopic cells, measure the effects on heart rate and blood pressure, etc. Each of these tasks teaches an important concept. In order to complete the tasks, certain technology and equipment is necessary.

Therefore, the use of technology is a fit for doing and learning the course content. Without technologies, students would not be able to experience or conduct experiments to learn about a particular concept. Overall, the use of technology is a fit for what Mr. Adams and Mr. Banks are expected to teach and what their students are expected to learn.

The third reflective journal question was: What social influences do you believe reflect Hmong students' beliefs about the usefulness of technology in this biology course? Both Mr. Adams and Mr. Banks explained social influences of the usefulness of technology for Hmong students. Mr. Adams stated lack of contact with technology and engagement and purposeful usage of technology as factors influencing Hmong students' belief of technology usefulness. Mr. Adams indicated that the school's culture of a lecture style teaching and learning environment influence students' awareness of technology use. According to Mr. Adams:

> I feel that many Hmong students are not aware of the usefulness of technology due to their lack of contact with current technology. Many of our courses, other than the PLTW and science courses, do not provide opportunities for our students to use technology.

Thus, if students are not exposed to the technology then they are not aware of the usefulness of the technology in supporting their learning. In addition, Mr. Banks believed that the direct engagement of students with technology as well as the purposeful use of technology will support students' beliefs about the usefulness of technology in biology. Mr. Adams noted:

> Students only become aware of technology's purpose when students are engaged and learn how to use data/visual programs such as Logger Pro, Autodesk Inventor or even Microsoft Excel. Students are able to connect what they are physically doing to the content they are learning; and see that technology allows data to be more efficiently collected, analyzed, transferred, and communicated.

Thus, technology will be useful to students when they are engaged with it in their learning. Furthermore, Mr. Banks included parent expectations of teachers as a social influence of students' beliefs of the usefulness of technology. According to Mr. Banks, Hmong parents trust teachers to teach their students so if teachers see the usefulness of technology to support student learning then students should also see the usefulness of technology. Mr. Banks added:

> I think that Hmong parents realize the necessity of education. They want their children to succeed in school, so they give their children the tools necessary for that end. They tend to defer to the experience and expertise of the teacher in the matters of the classroom.

Therefore, teachers' belief of the usefulness of technology has an influence on students' belief of the usefulness of technology. Overall, there are social influences that reflect Hmong students' beliefs about the usefulness of technology in biology class.

The fourth reflective journal question was: What personal factors do you believe influence Hmong students' beliefs about the usefulness of technology in this biology course? Mr. Adams believed that the personal factor regarding community of limited technology use influences students' beliefs about the usefulness of technology while Mr. Banks believed that the embrace of technology and hands-on activities affect the usefulness of technology. According to Mr. Adams, lack of technology experience is connected to lack of technology usefulness. Mr. Adams stated:

> Many of our Hmong students are only involved with school activities or Hmong community events. They lack the confidence and initiative to go outside the Hmong community for resources or leisure. Therefore, Hmong students are greatly impacted by their community that has very limited contact with new technology. These individuals are unable to reinforce or speak about the usefulness of technology due to their very own lack of experience.

Therefore, the personal factor relating to the usefulness of technology is impacted by the Hmong communities' use of technology. On the other hand, Mr. Banks believed that the difference in Hmong youth experience with technology influences the usefulness of technology. Mr. Banks added:

> Young people tend to embrace technology more than their parents. I think they like doing hands-on activities using the technology that I have in my classroom. They understand that some of the biological materials we use need special equipment to handle and manipulate. They are willing to try out a new technology we have.

Therefore, Hmong students' willingness to try out new technologies and explore hands-on activities supports the usefulness of technology in biology. Overall, there are personal factors relating to culture and experience that influences Hmong students' beliefs about the usefulness of technology in biology class. Table 9 describes the categories that I constructed from my analysis of the teacher reflective journal data.

Table 9

A Summary of Categories Constructed from Teacher Reflection Journal Data Analysis

Reflective Journal Question	*Categories*
TRJQ1: expected to learn	Become resourceful individuals
	Proficient user of technology
TRJQ2: task fit	Technology support teaching and learning
TRJQ3: social factors	Lack of contact with technology
	Engagement and purposeful usage
	Parent expectation of teachers
TRJQ4: personal factors	Community of limited technology
	Embrace of technology and hands-on activities

Note. TRJQ = teacher reflective journal question

Analysis of Course Documents Data

A content analysis was conducted for the course documents as recommended by Merriam (2009). There were five criteria used for content analysis of the course document. The five criteria included purpose, organizational structure, content, and use. The content analysis for these documents is organized according to the type of course document data. The content analysis was not organized according to each individual teacher because each teacher provided the same documents.

Standards Alignment. The analysis of the standards and objectives alignment included purpose, organizational structure, content, and use. In terms of purpose, the purpose of the standards and objectives alignment is to align all units, lessons, activities, and projects to the Common Core State Standards (CCSS) for English Language Arts (ELA), Common Core State Standards for Mathematics in high school, Next Generation Science Standards (NGSS), National Healthcare Foundation Standards and Accountability criteria, International Society for Technology in Education (ISTE) National Educational Technology Standards, and International Technology Education Association's (ITEA) Standards for Technology Literacy: Content for the Study of Technology. The alignment of technology standards indicated that technology innovations are integrated into high school biology courses.

In terms of organizational structure, the PLTW Standards and Objectives Alignment is a 63 pages document. Each set of standards is selectively identified in each lesson. Pages 1 through 25 served as alignment for each lesson to the CCSS for ELA. The CCSS for ELA alignment identified the reading standards for key ideas and details, writing standards for text types and purpose, speaking and listening standards for comprehension and collaboration, and language standards for conventions of standard English. Pages 25 to 29 aligned each lesson to the Next Generation Science Standards of molecules to organisms: structures and processes, engineering design, and heredity: inheritance and variation of traits. Pages 30 to 54 aligned each lesson to the National Healthcare Foundation Standards and Accountability Criteria for academic foundation, communications, teamwork, information technology applications, employability skills, safety practices, health maintenance practices, and technical skills. Pages 54 to 63 aligned each lesson to the CCSS mathematics for high school in number and quantity, algebra, functions, statistics and probability, and geometry. In addition, there are standards matrix table for alignment of each unit to CCSS Math and ELA, ISTE National Educational Technology Standards, ITEA Standards for Technology Literacy: Content for the Study of Technology, National Healthcare Foundation Standards and Accountability Criteria, and the National Science Education Standards (NSES). The organizational structure of standards and objectives alignment indicated that technology innovations are integrated into high school biology courses.

In terms of content, the standards and objectives alignment of both lesson and unit plans included standards aligned to the content area of English language arts, mathematics, science, healthcare, educational technology, and technology literacy. Standards that are conceptual to science understanding and skills included the NSES and the National Health Foundation standards. Standards that are conceptual to technology understanding and skills included National Educational Technology standards and

Technology Literacy standards. The content of the ISTE National Educational Technology Standards and the ITEA Standards for Technology Literacy indicated that technology innovations are integrated into high school biology courses.

In terms of use, 9 of the 20 ITEA Standards for Technology Literacy: Content for the Study of Technology aligned to all six units of the innovative technology course. All six National Educational Technology Standards aligned to all six units of the innovative technology course in terms of creativity and innovation, communication and collaboration, research and information fluency; critical thinking, problem solving, and decision making; digital citizenship, and technology operations and concepts. Standard 11: Information Technology Applications of the National Healthcare Foundation Standards also focused on the use of technology in the innovative technology course. In terms of information technology alignment, students are able to communicate using technology via fax, e-mail, and internet; and recognize technology applications in healthcare for all six units of the innovative technology course. The NSES Content Standard E and F also aligned to the use of technology. In terms of Standard E: Science and Technology, all students should develop abilities of technological design and understandings about science and technology in all six units. In terms of Standard F: Science in Personal and Social Perspectives, all students should develop understanding of science and technology in local, national, and global challenges in three of the six units. The use of technology as identified in the lesson and unit plans alignment of ISTE National Educational Technology Standards, ITEA Standards for Technology Literacy, National Healthcare Foundation Standards, and the National Science Education Standards indicated that technology innovations are integrated into high school biology courses.

Instructional guidelines: unit plan. The analysis of the unit plan included purpose, organizational structure, content, and use. In terms of purpose, the purpose of the Unit Plan is to provide an overview of each lesson and activity, serve as a pacing guide with instructional days, include teaching notes and directions for students to use science technology and software, and provide a list of resources for each lesson and activity.

In terms of organizational structure, the Unit Plan included relevant information for teaching each lesson. Each unit plan included teacher notes for both the lessons, activities, and projects. The structure of the unit is identified as:

Unit Two – Communication (38 Days)

- Lesson 1: The Brain (9 Days)
  - Activity 2.1.1 - The Power of Communication
  - Activity 2.1.2 - Build-A-Brain
  - Project 2.1.3 - Map-A-Brain
- Lesson 2: Electrical Communication (15 Days)
  - Activity 2.2.1 - The Neuron
  - Activity 2.2.2 - The Secret to Signals
  - Project 2.2.3 - Reaction Time
  - Activity 2.2.4 - It’s All in the Reflexes
  - Activity 2.2.5 - Communication Breakdown
- Lesson 3: Chemical Communication (6 Days)
  - Activity 2.3.1 - The Hormone Connection
  - Project 2.3.2 - Hormones Gone Wild
- Lesson 4: Communication with the Outside World (8 Days)
- Lesson 4: Communication with the Outside World (8 Days)
  - Activity 2.4.1 - Exploring the Anatomy of the Eye
  - Activity 2.4.2 - Visual Perception

Project 2.4.3 - Put Yourself in Someone Else's Eyes (Optional, additional 3 Days)
Activity 2.4.4 - Eye Care Professionals

The organizational structure of the Unit Plan allowed for technology innovations to be integrated into high school biology courses.

Instructional guidelines: lesson plan. The analysis of the lesson plan included purpose, organizational structure, content, and use. In terms of purpose, the purpose of the Lesson Plan is similar to the Unit Plan with detailed description to provide an overview of each lesson and activity, serve as a pacing guide with instructional days, include teaching notes and directions for students to use science technology and software, and provide a list of resources for each lesson and activity.

In terms of organizational structure, the Lesson Plan included relevant information for teaching each activity. While the Unit Plan included teacher notes, the Lesson Plan did not. Each lesson plan included a preface to the lesson, key understandings, knowledge and skills expectations for students to know and be able to do, essential questions, key terms, national and state standards alignment, day-by-day plans, instructional resources, and a list of references used in each lesson.

In terms of content, the content for this lesson plan is electrical communication. Regarding electrical communication, students will be learning about neuron, neural signals, reaction time, reflexes, and communication breakdown. The pacing of the lesson content included 15 days. On day 1 and 2, students will be learning about neuron with Activity 2.2.1 - The Neuron. On day 3 and 5, students will learn about the secret to signals with Activity 2.2.2 - The Secret to Signals. From day 5 to 7, students will learn and complete the project, Project 2.2.3 - Reaction Time. On day 8 to 10, students will learn about neural reflexes with Activity 2.2.4 - It's All in the Reflexes. Lastly, from day 11 to 15, students will learn about communication breakdown with Activity 2.2.5 - Communication Breakdown.

In terms of use, similar to the Unit Plan, technology is also embedded in the lesson plan. The use of computer is important to complete all lessons and activities, and for research:

Activity 2.2.1 - The Neuron (Day 1-2)

- Science Technology
    - Electric circuits
- Educational Technology
    - Computer with internet access
    - Online Anatomy reference textbooks
    - Inspiration software

Activity 2.2.2 - The Secret to Signals (Day 3-4)

- Science Technology
    - On-line Action Potential activity (generate electrical impulse)
- Educational Technology
    - Computer with internet access
    - Animation: 1 hyperlink
    - Online article: 1 hyperlink

Project 2.2.3 - Reaction Time (Day 5-7)

- Science Technology
    - On-line simulation Fastball Reaction Time activity
    - On-line simulation Time to Think activity
- Educational Technology
    - Computer with internet access

Activity 2.2.4 - It's All in the Reflexes (Day 8-10)

- Science Technology
    - Vernier LabQuest Mini with USB cable
    - Vernier EKG sensor with adhesive pads
    - Vernier 25-g Accelerometer
    - Reflex hammer

- Educational Technology
    - Computer with Vernier Logger Pro software

Activity 2.2.5 - Communication Breakdown (Day 11-15)

- Educational Technology
    - Computer with internet access
    - On-line Brain atlas

The lesson plan of the use of both science technology and educational technology indicated that technology innovations are integrated into high school biology courses.

End of course assessment. The analysis of the End of Course (EoC) assessment included purpose, organizational structure, content, and use. In terms of purpose, the EoC assessment is a cumulative or summative test designed by PLTW for the purpose of measuring student performance in the year long course. The organizational structure of the EoC assessment is a nationalized computerized test administered at the end of the school year. All test questions were constructed by PLTW and teachers are not allowed a preview of the test. Teachers are aware of the content to be assessed but they do not know the questions to be assessed. All students were provided with a username and password to gain admission to take the test. The test is administered by the science teacher. Student scores are available to teachers within a 24- hour period. This assessment used the stanine score scale. Thus, when students take the test, the scores they received will reflect their achievement levels. The score distribution ranged from one to nine with one being the lowest level of student performance and nine being the highest level of student performance. A score of one to three is designated as below average, four to six as average, and seven to nine as above average. Students with a score in the range of six to nine will receive college credit for their performance.

The results of the EoC included three innovative science courses. The first innovative biology course reported an aggregated score of 2.78 scored below the national mean of 5; 22 students performed below average, two students performed average, and one student performed above average. The highest score is a six. One of 25 students received college credit for the first innovative biology course. The second innovative biology course reported an aggregated score of 2.44 scored below the national mean of five; 19 students performed below average, two students performed average, and one student performed above average. The highest score is a seven. One of 22 students received college credit for the second innovative biology course. The third innovative biology course reported an aggregated score of 2.78 scored below the national mean of 5; 23 students performed below average, two students performed average, and zero student performed above average. The highest score is a five. No students received college credit for the third innovative biology course.

The organizational structure of the EoC Assessment indicated that technology innovations are integrated into high school biology courses, but student performance on the EoC Assessment indicated low student achievement. The test measured content knowledge in each of the innovative high school biology courses. The types of question included only multiple-choice. The multiple-choice questions assessed student understanding of course content, materials used in the course such as science technology and biology technology, application of technologies used in the course, science skills, and interpretation of data from lab experiments. The question types of both science content knowledge and science technology content knowledge in the EoC Assessment indicated that technology innovations are integrated into high school biology courses.

In terms of use, students take the EoC assessment using computer technology. The test is a computerized test administered using a computer with internet connection. Students were given their own personal username and password to log in to take the test. The use of computers to take the EoC Assessment indicated that technology innovations are integrated into high school biology courses.

Data Analysis: Level 2 Emergent Themes

At the second level, which is the cross case analysis, I examined the data for emerging themes and discrepant data, which formed the key findings for this study. In this study, I examined the level 1 coded and categorized data across all sources of evidence and across all cases for emerging patterns, themes, and relationships. I analyzed the categorized data from both the interview and reflective journal to determine six emergent themes. The emergent themes included educational and biology technologies, technology usefulness is positive, technology ease of use is easy, impact of technology use is positive, technology acceptance: outcome, personal, task-fit, and cultural factors, and technology has a positive influence on learning biology content.

Educational and Biology Technologies

Both students and teachers in embedded analysis 1 and 2 noted that the types of technologies used in the innovative biology course included educational technology and biology technology. The educational technology included computers (laptops, desktops, and tablets), software (LoggerPro and Inspiration), and web service (Google classroom and Learning Management System). Similarly, students and teachers reported biology technology as lab tools (gel electrophoresis, microscopes, diffuser, scalpel, electronic scale, caliper, centrifuge, vortexer, micropipettetors, hot water baths, and thermocyclers), medical tools (stethoscope, blood pressure cuffs, and pocket fetal Doppler), and probes and sensors (Vernier probes, heartrate monitor, LabQuest mini, EKG electrodes, spirometer, O2 gas sensor, and dynamometer).

Technology Usefulness is Positive

Both students and teachers in embedded analysis 1 and 2 indicated that the technologies used in the innovative biology course are useful or very useful. Therefore, the usefulness of technology is positive for all students and teachers. However, students indicated that the usefulness of technology is very useful and useful while teachers indicated that it is only useful. Students believed the technologies are very useful in providing hands-on experiences and enhancing learning and understanding of biology content. In addition, students believed technology is useful to provide hands-on experiences in science, science career exploration, form science understanding, provide easy access to resources, and task completion. Likewise, teachers believed technology is useful to conduct high level labs, increase exposure to technical science, intentional and purposeful use of technology, prepare students for college labs, and is relevant and relatable to science professionals. Overall, both students and teachers believed the usefulness of technology is positive in the innovative biology course.

Technology Ease of Use is Easy

All students in embedded analysis 1 and 2 shared similar theme regarding the ease of use of technologies. Students reported the ease of use of technology to be easy and not easy but they can learn how to use it. Students believed that computers in general are easy to use because they are familiar with the use of computers. Students also reported that specific lab peripherals are also easy to use if they follow the directions in the instruction manual step by step. On the other hand, students indicated that if they are not familiar with specific lab peripherals, then it is not easy to use the technology. Students believed it is not easy to use the specific peripherals at first but they can learn how to use the technology from their teachers and it will become easier as they use it more. As for teachers, both teachers reported that the technologies are easy to use but they need time to learn the technology to effectively teach it well to their students. In addition, although the technology is easy to use, the teachers still need to take the time to become familiar with how it functions so they feel competent to answer questions from their students. Overall, the technologies used in the innovative biology course are easy to use for both students and teachers.

Impact of Technology Use is Positive

Both students and teachers in embedded analysis 1 and 2 reported that their experiences with technology has a positive impact on Hmong student learning in biology classes. Thus, the impact of technology use is positive for Hmong student learning. Hmong students believed the learning impact of technology is positive since technology allows students to communicate with their bodily functions, connect learning and understanding of biology content, and develop deeper understanding of biology content. In addition, the impact of technology is positive because learning with technologies increases memory and interest, increases understanding, and students enjoy learning and are excited about the biology content, Furthermore, the experiences with technology allowed students to learn about the use and purpose of technology, and technology makes learning fun and engaging. Students indicated that they are motivated to learn more and are motivated to learn about biology with technology. Also, students stated the impact of technology to be positive as the use of technology is relevant to their future career interest, supports test preparation, and allows them to understand the tools, skills, and techniques of science investigation. Overall, students believed that technology has a huge impact on their learning in biology class and technology has been embedded as a part of their course in order to complete their assignments.

As for teachers, both teachers stated that their experiences with technology has a positive impact on Hmong student learning. The impact of technology is positive for Hmong student because it creates excitement for students to pursue health careers, it exposes them to technologies they don't experience in their community, and teaches them applicable skills that are relevant and relatable to their life. In addition, the huge impact of technology is in providing hands-on experiences for Hmong students so they actually get to use the equipment to support their learning. Overall, the teachers believed that technology has a positive impact on Hmong student learning in biology class.

Technology Acceptance: Outcome, Personal, Task-Fit, and Cultural Factors

Both students and teachers believed there are factors that influence Hmong students' acceptance of technology in biology class. Students reported that their acceptance of technology is due to outcome expectancy, personal factors, and TTF. Students indicated that they accepted technology for the positive outcome of their learning or experiences. The positive outcome of technology acceptance included the actual use and benefit of technology contribution toward student learning, ease of use of technology as easy, efficiency of technology to get work completed, and the usefulness of technology to help students learn and to motivate them. Motivation is important for students because if they are interested in the actual use of technology then they will be motivated to learn. Also, students accept technology when they see the importance of technology to support their learning where the results they acquired with technology makes sense to them.

Personal factor is another influence of Hmong students' acceptance of technology. Students' personal factors such as their experience with technology, how common technology is to them, and the relevancy of technology is what allows students to accept technology. Besides personal factors, students believed that the task-fit of the technology also plays a role in their technology acceptance. Students believed that the usefulness of technology in terms of what technology can do for them is what allows them to accept technology. Therefore, technology is a task-fit because technology is useful in helping students learn and understand biology content as well as help students finish their experiments and assignments.

Similar to students, teachers reported Hmong students' acceptance of technology is due to personal factors. In addition, teachers believed cultural factors also influences Hmong students' acceptance of technology. According to teachers, the two personal factors influencing Hmong students' acceptance of technology are willingness to learn and familiarity with technology. Hmong students will accept technology because they are willing and ready to learn anything. In addition, Hmong students' familiarity with technology can affect their ability to go out of their way to actually use the equipment. The teachers stated that if students are not used to the technology or have not used it before, then there is a resistant factor at first but they will eventually use the equipment once they have an idea of what to do.

Technology Has a Positive Influence on Learning Biology Content

Both students and teachers reported factors that influence Hmong students' learning of biology content when they use technology to assist them. Students indicated that technology has a positive influence on Hmong students' ability to learn biology content. The factors included access to research, attitude toward learning, motivation, social influence, and use and importance of technology. Students said the use of technology has helped them learn the biology content better and they feel that technology has a positive impact on their learning of biology content. The use of technology provided students with a better attitude toward their learning. The use of technology helps students learn and understand the science process, thus increases their understanding of biology content. Also, the use of technology motivates students to learn and go deeper with their knowledge of biology because it draws them with a desire to learn more about how something works. In addition, students believed that social factors from their peers and teachers has influenced their learning of biology content with technology. Hmong students believed that their peers and teachers' positive attitude toward technology has a direct effect on their own attitude. Therefore, if their friends and teachers believed that technology is important and it will help them learn and do better in class then students will feel the same way too. Overall, students noticed the use and importance of technology and see the benefit of using technology to support the learning of biology content. Students believed technology is useful and appropriate for what they are doing in class, and it would be hard for them to learn about biological processes and to complete a high-level lab if they do not have access to technology. Also, students believed that the use of technology creates meaningful learning for them and allows what they see in the textbook to be learned in reality.

While students reported a positive influence of technology on the learning of biology content, teachers stated that technology has both a negative and positive influence on Hmong students' ability to learn biology content. The negative factors on student learning of biology content included technology to be not engaging, not relevant to life and career, and is outdated. The positive factors on student learning of biology content included technology to increase understanding, to be used intentionally, and to be relevant to life and career. Therefore, teachers believed that if technology is used with a purpose, it is intentional, and is relevant to Hmong students' life and career choices then it increases their learning and understanding of biology content. On the other hand, if technology is not used intentionally and becomes boring as well as not relevant to Hmong students' life and career choices then students become disengaged. Therefore, the teachers believed that they need to know how to use technology efficiently and effectively to support Hmong student learning of biology content.

Discrepant Data

In terms of discrepant data, I looked for any significant discrepancies between and among all data sources that challenge the theoretical proposition (Yin, 2014) for this study, which is the impact of technology innovations on science learning for Hmong students. The theoretical proposition for this study is that although Hmong students often struggle with learning science as indicated in the literature review, the impact of technology innovations on science learning for Hmong students was positive. Interview and reflective journal data supported this theoretical proposition because both students and teachers in both embedded analysis group reported that the use of technology innovations in biology class positively impacted students learning of biology content. Although one student noted a negative usefulness of technology as it causes online distraction, the student did not challenge the theoretical proposition of this study. The student noted that the online distraction is more of an accountability issue rather than a negative impact of the use of technology. In this situation, the student noted that she would try to do her work at home but instead she is easily distracted from social media and it takes her longer to complete her work at home then at school. Overall, the use of technology positively impacts Hmong students' learning of biology content.

Evidence of Trustworthiness

Trustworthiness in qualitative research is important to ensure ethical manner in the study to generate valid and reliable results (Merriam, 2009). Carlson (2010) added that "trustworthiness is gained when researchers show that their data were ethically and mindfully collected, analyzed, and reported" (p. 1110). The quality of any research design is dependent on "trustworthiness, credibility, confirmability, and data dependability" (Yin, 2014, p. 45). Similarly, Merriam (2009) added that the trustworthiness of qualitative research is dependent on credibility, transferability, dependability, and confirmability. In this study, I applied specific strategies of credibility, transferability, dependability, and confirmability to improve the trustworthiness of this qualitative research.

Credibility

Credibility is defined as how research findings match reality to present a holistic interpretation of what is happening between the research and the real world (Merriam, 2009). For this study, I used the strategy of data triangulation to compare and contrast multiple data sources such as student interviews and student reflective journals, teacher interviews and teacher reflective journals, and course documents to support my findings. Triangulation allows me to gather and analyze data in more than one way with different people at different time and location where Carlson (2010) stated that if I can substantiate these various data sets with each other, then the interpretations and conclusions are likely to be trustworthy. I also used the strategy of member checks to ask for participant feedback and review of the tentative findings of the study to ensure credibility. In addition, I also used the strategy of adequate engagement in data collection by spending several days at the research site to thoroughly conduct interviews and collect course documents.

Transferability

Transferability is defined as the extent in which the findings of one study is applicable to other situations or contexts (Merriam, 2009). For this study, I used rich thick description to provide a highly detailed description of the research setting and participants. I also provided a detailed description of the data collection and analysis protocols, and the findings of the study. The purpose of rich thick description is to allow the findings to be transferred to another context, thus maximizing transferability.

Dependability

Dependability is defined as the ability to replicate research findings (Merriam, 2009). For this study, I used the strategies of triangulation and audit trail. Similar to what I used triangulation for to ensure credibility, triangulation was also used to ensure dependability of consistent and dependable data of multiple sources. In addition, I used the strategy of audit trail to keep a running record of my reflections, questions, and decisions regarding problems, issues, or ideas encountered during data collection, analysis, and interpretation process.

Confirmability

Confirmability is defined as researcher values and expectations rather than research biases (Merriam, 2009). For this study, I used the strategy of reflexivity to explain my role as the sole researcher and to explain any biases, dispositions, or assumptions regarding the research. In addition, I also used a journal to record my research experiences as a method to reflect and understand my personal biases about the use of technology for Hmong students in biology class.

Results

These findings were analyzed in relation to the central and related research questions and interpreted in relation to the literature review and the conceptual framework of the study. In this study, the three instruments of interview guides, course documents, and reflective journals were aligned to the related research questions and the central research question. The student interview questions were aligned to related research question 1. The teacher interview questions were aligned to related research question 2. The course documents were aligned to related research question 3. In addition, both students and teachers' reflective journals were aligned to the central research question. In this section, an analysis of the three related research questions were presented first followed by a synthesis of the central research question. The results will be presented in a summary table at the end of this section.

Related Research Question 1

The first related research question was: How do Hmong students perceive the usefulness and ease-of-use of technology innovations in high school biology courses? The major finding from the literature review and conceptual framework in relation to this question was that the presence of technology in the learning environment resulted in positive experiences for students. Results of the data analysis supported the finding that Hmong students perceived the usefulness of technology innovations in high school biology course to be positive. Hmong students stated that technology is useful in two-fold. First, it provides them with positive active science learning opportunities while allowing them to complete required tasks. Second, the usefulness of technology is that it positively impacts students' learning of biology content in biology class.

In terms of positive science experiences, interview data from both embedded analysis group indicated that technology was useful to provide Hmong students with hands-on science experiences. Both David and Eva reported that technology is useful to help them build science experiences as well as help them form understanding of the concept they are learning as well as the task they are doing. by learning through hands-on and through experiencing with technologies, Guy and David stated that by learning through hands-on experiments with technologies they get a better understanding of what to do and how to do it better. The usefulness of technology for hands-on experience with science learning also allow students to see science in real time. Beth, Cora, and Flo agreed that technology is useful in allowing them to read about a concept in a textbook then using technology to try and test or collect data to support what is in the text. Also, by doing the experiment they are able to understand the materials better than reading about it. Flo added that the use of technology teaches them scientific concepts or things that they may never get to see on a daily basis. Thus, technology provides a text to reality experience for these students. In addition, students in both groups also found technology to be useful in helping them accomplish or complete the task they are required to do. Amy, Eva, Flo, Guy, and Henry believed that the technologies they used in class are useful because it allows them to record and track what they are doing, measure what they needed to measure, and back up lab data for analysis so they can complete their experiments. In addition, they found the use of technology to be useful to obtain accurate results and beneficial in measuring for quantitative data such as lung volume, lung capacity, and grip strength. Therefore, students believed that without technology, they will not be able to accomplish the given tasks.

In terms of the impact of students' learning of biology content in biology class, students in both analysis group believed that technology has a positive impact on their learning. The most prevalent impact on students' learning in biology included increase understanding of course content, tools, skills, and science techniques; and increase motivation and engagement. In terms of increase understanding, Beth, Cora, David, Eva, Flo, and Guy reported that when they used technology, the use of technology provides connection between learning and understanding, and allows them to develop a deeper understanding of the materials in class. Also, Beth and David said they developed a deeper understanding of science when they are able to do something in the class that is related to what they are learning, and by doing that then they are able to remember more to help them more. In terms of motivation and engagement, Beth, David, Guy, and Henry reported that technology has an impact on their interest to learn science. All four students indicated that they were excited about coming to class and they were more interested in the class when they get to use technology to conduct science investigation. David and Henry stated that the use of technologies made learning fun and they were motivated to come to class with a desire to learn more about the content and the use of technology. In addition, Beth and Guy indicated that technology impacted their learning because they enjoy learning about the content with technology and when learning becomes fun then they are able to learn the materials better and remember it more. Thus, the usefulness of technology is having a positive impact on students' learning in biology class.

Furthermore, results of the data analysis also support the finding that Hmong students perceived the ease of use of technology innovations in high school biology course to be positive. In general, all students in both analysis group believed that the use of educational technology such as computers and the use of biology technology such as specific lab peripherals were easy to use. Amy, Beth, David, Flo, and Henry reported that they are used to computer technologies so it was easy to use and they can easily navigate computers, computer software, and lab technologies. On the other hand, Cora, Eva, Guy, and Henry reported that the use of specific lab peripherals was not easy to use at first but they eventually learned how to use it with more practices. These students stated that they were able to overcome the challenge of using specific peripherals by asking their teachers and peers, taking the time to read the instruction manuals, being careful, and troubleshooting on their own when they are not sure what to do. Overall, all students experienced a positive use of both educational and biology technology.

Related Research Question 2

The second related research question was: How do high school biology teachers perceive the usefulness and ease-of-use of technology innovations for Hmong students in their courses? The major findings from the literature review and conceptual framework in relation to this question was that perceived ease of use and perceived usefulness are the predictors of teachers' attitude toward technology use. Also, the literature suggested that teachers' perceived beliefs and attitude toward technology are factors affecting their use of technology for teaching. Results of the teacher interview data analysis supported the finding that high school biology teachers perceived the usefulness of technology innovations in high school biology course for Hmong students to be positive. Both teachers viewed technology positively to engage students with learning and prepare students for higher learning.

Both Mr. Adams and Mr. Banks reported technology as useful and positive for promoting higher learning in students. They stated that technology increases student exposure to higher technical science. Mr. Banks said the use of biology technologies allow students to experience high level levels within a high school setting. Similarly, Mr. Adams reported that the availability and use of biology technologies exposes students to the same kind of technologies that doctors use in the medical field. Thus, both teachers believed that it is useful for students to conduct higher level labs and learn applicable science skills as science professionals. Mr. Banks added that exposure to higher technical science and higher-level labs prepares students for more advanced sciences and how to handle complex technologies appropriately when they get to college.

In addition, the perceived usefulness of technology is positive for Hmong students because teachers believed that it has a positive impact on student learning in biology class. The teaching of biology with technology is useful in activating teaching and learning. Mr. Adams believed that technology integration and the actual use of technology is helpful to students because it allows students to actually use the equipment and apply hands-on skills rather than listening to lectures. Also, both teachers believed that Hmong students have limited exposure to technology so the use of technology in the classroom creates opportunities for students to learn other technologies beside a computer, phone, or tablet. In addition, Mr. Banks stated that the use of technology teaches student science skills that they can relate to, use, and apply it at home. With the relevant skills students acquired in class through technology, Mr. Banks added that it creates excitement for students to pursue health career as students become more and more educated with science.

Results of the teacher interview data analysis supported the finding that high school biology teachers perceived the ease of use of technology innovations in high school biology course for Hmong students to be positive. The ease of use is positive because both teachers believed that students are able to use both educational and biology technologies with ease. The technologies were easy for students to use. Mr. Adams stated that one reason why biology technologies are easy for students to use is because they are supported with instruction manuals and tutorial videos. Thus, students are able to operate, run, and maintain specific biology peripheral technologies on their own.

Related Research Question 3

The third related research question was: What do course documents reveal about how technology innovations are integrated into high school biology courses? The major finding from the analysis of the three course documents indicated that the use of technology is a significant component of the innovative biology course. All three course documents showed evidence of technology use. The two course documents of course descriptions and standards alignment and unit and lesson plan supported technology standards and types of technologies used in the biology course. In addition, the course document of the EoC assessments as a computerized test support the knowledge and understanding of students to use technology to complete an assessment.

The alignment of technology standards in both unit and lesson plans indicated that technology innovations are integrated into high school biology courses. Both the unit plan and the lesson plan are aligned to technology standards. The standards aligned with the objectives of the daily lessons included the ISTE National Educational Technology standards and the ITEA Standards for Technology Literacy: Content for the Study of Technology. In analysis of Unit 2 regarding ITEA standards, five of the 20 ITEA Standards for Technology Literacy were addressed and assessed. The five ITEA standards included standards 3, 4, 12, 14, and 17. Standards 3 is students will develop an understanding of the cultural, social, economic, and political effects of technology. Standards 4 is students will develop an understanding of the effects of technology on the environment. Standards 12 is students will develop the abilities to use and maintain technological products and systems. Standards 14 is students will develop an understanding of and be able to select and use medical technologies. Standards 17 is students will develop an understanding of and be able to select and use information and communication technologies.

In analysis of Unit 2 regarding ISTE standards, all six standards along with the 24 sub-standards aligned to the objectives and activities of Unit 2. For Standard 1 – Creativity and Innovation, three of the four sub-standards showed a direct correlation in ideas and concepts between the standards and all lessons in the unit while one sub-standard showed a direct correlation in ideas and concepts between the standard and some lessons in the unit. For Standard 2 – Communication and Collaboration, two of the four sub-standards showed a direct correlation in ideas and concepts between the standards and all lessons in the unit while one showed a direct correlation in ideas and concepts between the standard and some lessons in the unit. For Standard 3 – Research and Information Fluency, three of the four sub-standards showed a direct correlation in ideas and concepts between the standards and all lessons in the unit while one showed a direct correlation in ideas and concepts between the standard and some lessons in the unit. For Standard 4 – Critical Thinking, Problem Solving, and Decision Making, two of the four sub-standards showed a direct correlation in ideas and concepts between the standards and all lessons in the unit while one showed a direct correlation in ideas and concepts between the standard and some lessons in the unit. For Standard 5 – Digital Citizenship, two of the four sub-standards showed a direct correlation in ideas and concepts between the standards and all lessons in the unit while one showed a direct correlation in ideas and concepts between the standard and some lessons in the unit. Lastly, for Standard 6 – Technology Operations and Concepts, two of the four sub-standards showed a direct correlation in ideas and concepts between the standards and all lessons in the unit while two showed a direct correlation in ideas and concepts between the standard and some lessons in the unit. Overall, the lessons in the unit are aligned to the ISTE National Educational Technology Standards to indicate high quality and quantity of technology use.

Besides a strong alignment of technology standards to activities, the unit and lesson plans also included the technologies that will be embedded in each lesson. The lesson plan listed the technologies as materials and provided detail step by step directions for students to follow. Within the lesson plan, the software was clearly identified as LoggerPro and Inspiration, and the biology technologies were clearly identified as LabQuest Mini, EKG sensor, accelerometer, and PASCO eye model. The careful and purposeful planning of technology use within the lesson plan indicate that technology innovations are integrated into high school biology courses. Furthermore, the activities that students are required to complete using technology indicate that students are able to communicate using technology to access and distribute data and other information, and utilize computer hardware and software. By allowing students to use technology in the biology course, students learned, acquired, and demonstrated understanding of technology concepts, systems, and operations.

In addition, the analysis of the EoC assessment suggested that the use of computers to take the EoC Assessment indicated that technology innovations are integrated into high school biology courses to the extend where the final assessment requires technology to complete. By taking the assessment on the computer, this suggested that students understand technology systems and can transfer current knowledge to learning of new technologies. In addition, the questions on the assessment also measured students' understanding of the technologies they have used in the course where they need to analyze similar data sets they have encountered in the class.

Central Research Question

The central research question was: How do technology innovations in high school biology courses impact science learning for Hmong students based on a technology acceptance model? Findings from both the student and teacher reflective journals and interview data were used to support the central research question. The major finding from this study is that technology innovations has a positive impact on science learning of biology content for Hmong students. The positive impact is due to usefulness, ease of use, and technology acceptance.

In terms of the positive impact of technology usefulness, all eight students and two teachers stated that there are 10 positive usefulness of technologies. Although they identified 10 positive usefulness of technology, only three were prominent amongst all students and teachers. The three-positive usefulness of technology as indicated by students included hands-on experience, important for task completion, and enhance learning and understanding. Students believed the technologies they used in their biology classroom are useful because they get to experience it first hand and it helps build an understanding of what they are doing. Also, students reported that they can learn about science and science concepts in the textbook but if they don't actually do it then they may not understand the concept they are learning. Similarly, teachers believed that technology is used intentionally for students to experience and learn the science equipment. Therefore, students indicated that it really helped them understand concepts better when they are able to do it and see how science works. Likewise, teachers believed that students are able to understand concepts better when they do not rely entirely on the teachers for assistance and can use technology on their own for data collection and analysis, and internet queries,

In terms of task completion, students and teachers stated that technology is useful in biology class to complete biology tasks. Students indicated that technology is useful because without certain science technology then they will not be able to measure breathing rate, lung volume, or lung capacity; and they will not be able to do the experiment. Similarly, teachers believed that technology is useful because without technology then there is no way students can do and complete the type of labs such as oxygen capture in a high school setting. Lastly, regarding learning and understanding, students believed that technology is useful because it helps them learn and understand the process of science. Students believed they will not be able to better understand science concepts such as the functions of the human body without the use of the technologies in their classroom. Likewise, teachers added that the technologies students used exposes them to higher technical science and prepares them for more advanced science. Teachers believed that the exposure to complex technologies allow students to learn the equipment better and their learning of science relates to them better. Both teachers noted that students can use technology to access for clarification on science topics. Overall, the usefulness of using technology in biology class is positive for Hmong students as described by Hmong students and their science teachers.

In terms of the positive impact of the ease of use of technology, all eight students and two teachers stated that the technologies students used in biology class are easy to use. Students indicated that they were able to use the technology so they did not have any problem or challenges. Students noted that once they were shown how to use the technologies then it was easy for them to use and they were able to adjust to the technologies. Similarly, teachers added that once they instructed students on the use of the technologies in the classroom then students were able to use the technologies on their own, thus the use of technology was easy for students. Overall, the ease of use of both educational technologies such as computers and biology technologies such as specific science peripherals were found to be easy for Hmong students to use as expressed by both Hmong students and their science teachers.

In terms of the positive impact of technology acceptance, all students stated that Hmong students accepted the technologies they used in biology class due to outcome expectancy, personal factors, and TTF while teachers stated that Hmong students accepted technology due to cultural and personal factors. Regarding outcome expectancy, Hmong students reported that they accepted the use of technologies due to actual use and benefit, interest in the actual use of technology, ease of use, technology efficiency, perceived usefulness, and importance of technology. Regarding personal factors, students noted their experience with technology and the relevance and commonality of technology contributed to their acceptance of technology. On the other hand, teachers indicated that Hmong students' acceptance of technology in the classroom is due to their willingness to learn and their familiarity with technology. Regarding TTF, students stated that technology usefulness is why they accepted technology. Students believed that the capability of technology and what technology can do for them is the main reason why they accepted technology. Students stated that technology assists them in performing, recording, calculating, and accomplishing their assignments. Lastly, regarding cultural, teachers believed that Hmong students are compliant and they have no cultural objections to the use of technology. Therefore, teachers support the compliance of Hmong students rather than the resistance of technology as their acceptance of technology use. Overall, outcome expectancy, personal factors, TTF, and culture support technology acceptance for Hmong students.

Summary

Chapter 4 included a discussion of the results of the data analysis in connection to the three related research questions and the central research question for both user groups of embedded units of analysis 1 and embedded unit of analysis 2. Through both level 1 and level 2 data analysis, the following six themes emerged for Hmong students: (1) use of educational and biology technologies, (2) technology usefulness is positive, (3) technology ease of use is easy, (4) impact of technology use is positive, (5) technology acceptance is due to outcome expectancy, personal factors, task-fit, and cultural factors; and (6) technology has a positive influence on learning biology content. The key finding to related research question 1 is that Hmong students experienced a positive use of both educational and biology technology. The key finding to related research question 2 is that Hmong students perceived the usefulness of technology and the ease of use of technology innovations in high school biology course to be positive. The key finding to related research question 3 is that all three course documents of standards alignment, unit and lesson plans, and EoC assessments showed evidence of technology integration into the high school biology course. Lastly, the key finding to the central research question is that technology innovations has a positive impact on science learning for Hmong students. Also, the findings from the three related research questions and the central research question supported the TAM.

Chapter 5 will include an interpretation of the findings to describe in ways the findings confirm, disconfirm, or extend knowledge in the discipline by comparing the findings to what has been found in the peer-reviewed literature as described in Chapter 2. Also, the findings will be analyzed and interpreted in relation to the conceptual framework of Gu et al.'s (2013) modified TAM. Chapter 5 will also include a discussion of the limitations of the student, recommendations, implications, and a conclusion to capture the key essence of the study.

Chapter 5: Discussion, Recommendations, and Conclusion

The purpose of this study was to describe how technology innovations in high school biology courses impact science learning for Hmong students based on a TAM. I used a case study design consisting of two embedded analysis cases to conduct this qualitative investigation. The use of a case study was appropriate to collect multiple data sources to present a rich picture of how Hmong students use technology to learn science and to investigate the impact of technology innovations on science learning for Hmong students. This research was conducted in relation to a gap in the research about why Hmong students struggle in technology-focused science courses. In addition, little is known about students' experiences with technology (Beckman et al., 2014), no research exists on how Hmong students perceive the use of technology in science course (Lewis et al., 2003), and little is known about Hmong students' experience with technology in science courses. Furthermore, there is a lack of research about science teachers' belief about the impact of technology on science learning for Hmong students. Therefore, this study addressed the gap in the literature on how technology innovations in high school biology courses impact learning for Hmong students.

Six key findings emerged from the data analysis of both teachers and students' interviews and reflective journals, and course documents. The themes were in relation to the three related research questions and the central research question. Through both level 1 and level 2 data analysis, the following six themes emerged for Hmong students: (a) use of educational and biology technologies; (b) technology usefulness is positive; (c) technology ease of use is easy; (d) impact of technology use is positive; (e) technology acceptance is due to outcome expectancy, personal factors, task-fit, and cultural factors; and (f) technology has a positive influence on learning biology content.

Pertaining to related Research Question 1, Hmong students experienced a positive use of both educational and biology technology in biology course. The key findings included (a) use of educational technology and science technology, (b) technology is useful; (c) the ease of use of computer technologies are easy to use while science technologies are both easy and hard to use, (d) technologies impacted Hmong students' learning with deeper understanding, learning, and task completion, (e) Hmong students' acceptance of technology is influenced by relevance and commonality, results, efficiency, and usefulness; (f) Hmong students' learning of biology content is influenced by technology accessibility, increase understanding and learning, motivation, and social influence.

In terms of related Research Question 2, high school biology teachers perceived the usefulness of technology and the ease of use of technology innovations in high school biology course for Hmong students to be positive. The key findings of related Research Question 2 are similar to the key findings of related Research Question 1 with (a) use of educational and science technologies; (b) technology is useful for Hmong students; (c) ease of use of technology is easy for both teachers and Hmong students; (d) technologies positively impacted Hmong students' learning; (e) Hmong students' acceptance of technology is influenced by familiarity with technology, and compliance and willingness to learn; and (f) teachers believed Hmong students' learning of biology content is influenced by engagement, relevancy to life and career, outdated resources, increase understanding, and intentional use of technology.

In relation to related Research Question 3, all three course documents of standards alignment, unit and lesson plans, and EoC assessments showed evidence of technology integration into the high school biology course. All three course documents included purpose, organizational structure, content, and use. The key finding in terms of the purpose, organizational structure, content, and use for standards alignment, unit and lesson plans, EoC assessments is that technology innovations are integrated into high school biology courses.

In terms of the central research question, technology innovations have a positive impact on science learning of biology content for Hmong students. The positive impact of technology on science learning for Hmong students is influenced by usefulness, ease of use, and technology acceptance. The key findings to both Hmong students and biology teachers included (a) technologies used in biology class are useful; (b) usefulness of technology was influenced by hands-on experience, important for task completion, and enhance learning and understanding; (c) technologies used in biology class are easy to use; and (d) outcome expectancy, personal factors, TTF, and culture influenced Hmong students' acceptance of technology. Overall, all Hmong students and biology teachers in both embedded analysis groups believed technology influenced Hmong students' learning of biology and the findings from the data analysis supported the TAM.

Interpretation of the Findings

The findings of this study were interpreted based on the modifications of the TAM that Gu et al. (2013) developed. The four constructs of the TAM used to further explain the impact of science learning included outcome expectancy, TTF, social influence, and personal factors. Based on a TAM, outcome expectancy, TTF, social influence, and personal factors were found to have an impact on science learning for Hmong students.

Outcome Expectancy

The use of both educational and biology technology is an outcome expectancy for Hmong students and has an impact on science learning for Hmong students in biology course. Outcome expectancy is how an individual perceives technology should be used and is the user's acceptance of technology based on perceived usefulness or actual use of technology (Gu et al., 2013, p. 400). Gu et al. (2013) indicated that outcome expectancy consisted of usefulness, ease of use, relative advantage, and performance of the technology. In addition, the importance of outcome expectancy is that usefulness, ease of use, relative advantage, and performance of technology influenced the outcome of technology acceptance (Gu et al., 2013; Venkatesh et al., 2003). Both the interviews and reflective journals of teachers and students provided evidence to support the usefulness and ease of use of outcome expectancy. However, the research data did not confirm or extend relative advantage and performance of the technology.

In terms of outcome expectancy, Hmong students believed that the outcome of using technology was positive for their education. Students reported the positive outcome of using technology as allowing them to believe in what was being taught, helping them reflect on their learning and the understanding of taught materials, teaching them science process skills such as DNA extraction, accomplishing the required task of data collection, conducting research to find solutions to their questions, helping them to store and analyze data efficiently, providing feedback and results, providing opportunities for independent learning, and preparing students for new learning and what the course has to offer. The positive outcome expectancy of this research confirms the use of technology to increase thinking, writing, and problem-solving skills as found in other studies (Incantalupo et al., 2014; Lin & Lin, 2016; Neufeld & Delcore, 2017). Thus, data showed that when Hmong students see the outcome or the benefit of using technology to support their learning and understanding then they see the usefulness of technology. This finding confirms the research done by Nugraini et al. (2013), who found that students see the benefit of e-Audio Visual when they found out that the technology helped them in class experiments and to earn higher marks. The technology use kept their interest in biology. Although students in Nugraini's study were not Hmong, data in my study extends the literature to indicate that Hmong students may benefit from the technology use in biology class, as they reported that positive technology outcomes influenced their use of technology. In addition, the use of technology based on positive outcomes as found in my study also supports Staudt et al.'s (2015) study in that a connection between improved learning and positive experiences existed in the use of innovative technology in teaching science content. Similarly, in extension to Nugraini's study and my study, another study by Chen et al. (2013) confirmed positive technology outcomes in that web-based technology enhances student effectiveness in learning, increases learning productivity, improves learning performance, and enables students to accomplish learning more quickly. Overall, studies in the literature support positive outcome expectancy, and this study confirmed the result of positive outcome expectancy for Hmong students.

In addition, teachers also believed that the usefulness of technology was beneficial for Hmong students, as it allowed them to become resourceful individuals and proficient users of technology. Thus, the benefit of Hmong students being resourceful individuals and proficient users of technology is a positive outcome expectancy regarding the usefulness of technology. This finding supports the findings of Mac Callum et al. (2014) in that teachers see a substantial advantage to students' learning through mobile learning and teachers will adopt mobile learning due to the positive outcome toward student learning. Similar to the results from Mac Callum et al.'s study and my study, Ward and Purr (2010) confirmed that teachers used computers due to positive student outcomes rather than potential barriers. Odchazelova (2015) also explored teachers' use of multimedia in biology education and found that teachers accepted multimedia in biology education as the use of multimedia increased students' motivation, creativity, and support for students with special needs. In extension to the study of Mac Callum et al., Ward and Purr, and Odchazelova, the positive outcome expectancy of using technology in this study confirmed the positive outcome expectancy in the literature. Similarly, Li et al. (2012) confirmed that the benefits of the use of technology include the intention to use and reuse, and student satisfaction. Therefore, the positive outcome of teachers implementing the use of technology in their classroom is that they see the perceived usefulness of technology in developing students to become resourceful individuals and proficient user of technology.

Based on the positive usefulness of technology as reported by Hmong students and biology teachers as well as in the literature, they were satisfied with the use of technology in the innovative biology course. In addition, based on the positive usefulness of technology for Hmong students as reported by teachers, the teachers are also satisfied with the use of technology in their classroom. This finding confirms the literature of Yusoff et al. (2011) in that the success of a technology depends on how well students like the technology, how easy it is to use, and the technology's effectiveness. Thus, the results of my study support Yusoff et al's position, because both students and teachers see the potential of technology to support learning, students enjoy using technologies, technology is easy for students to use, and technology is effective for students to complete their work. Overall, Hmong students believed that outcome expectancy influenced their acceptance of technology in biology class due to actual benefit, efficiency, and usefulness. These findings were found to be true as expressed in the literature above. Thus, Hmong students are more likely to use technology when they have positive attitudes toward technology and perceive technology as useful.

In terms of ease of use, both Hmong students and teachers reported a positive ease of use of technology. Hmong students believed both educational and biology technologies are easy to use, which is consistent with the results from the literature. Although the literature was not focused on the population of Hmong students because studies on Hmong students were limited, the results of non-Hmong students in the literature reflected the results of Hmong students in this study. The findings of Shih, Chen, Wang, and Chen (2013) confirmed the ease of use of technology in that Taiwanese students understood how to operate the technology, students did not encounter difficulties in the use of the technology, and students felt it was very easy to learn from the technology. Similarly, Li, Duan, Fu, and Alford (2012) investigated Chinese students' use of e-learning systems and found that the e-learning system was easy to use and user-friendly. In another study, Zamani and Shoghlabad (2012) investigated the relationship between Iranian students' usage and TAM and found that using Internet search engines, sending or receiving e-mail and downloading files from Internet are all easy activities to perform. The results of this study even relate to Thai students, as Van De Bogart and Wichadee (2015) found that perceived ease of use influenced the acceptance of LINE as a user-friendly tool for Thai students' classroom-related activities. In addition, El-Gayer et al. (2011) reported that tablet PCs are easy to use or user-friendly and positively affect Midwest American students' attitude toward the use of tablet PCs. Chen et al. (2013) also supported easy technology use by showing that Taiwanese students found learning to operate a web-based instruction (WBI) system was easy, it was easy for students to get the WBI system to do whatever they want, it was easy for students to become skillful at using the WBI system, and students' interaction with the WBI system was clear and understandable. Similar to the results of these studies, data from my study confirmed that Hmong students found it easy to use technology. Thus, the transferability of technology as being easy to use is consistent in this study as in other studies in the literature.

Teachers indicated that they found it easy for Hmong students to use the technology once it was introduced to them. Teachers also found it easy to use the technology and to teach it to Hmong students. The ease of use of technologies by teachers and Hmong students support technology complexity based on perceived ease of use. Aypay, Celik, Aypay, and Sever (2012) explored teachers' level of technology acceptance in Turkey and found that technological complexity plays the greatest role on perceived ease of use. In other words, teachers developed positive perceptions toward the use of technological products when the technology is simple to operate. One extension from this literature is that when technology is perceived complex, it may hinder technological acceptance. Although this extension was not present in the research, it is possible that Hmong students may develop negative ease of use if the technology is difficult to use. However, this perception may be unlikely as Hmong students indicated that their familiarity with technology and having instructional manuals and tutorial videos provided support for technology use. Overall, both students and teachers' perceptions of the degree of ease associated with technology has a positive influence on their perception of technology usefulness and acceptance.

In all, the findings in this research support that the actual use of educational and biology technology by Hmong students reflected what they are expected to learn and is useful based on outcome expectancy. Both Hmong students and teachers believed that the use of educational and biology technologies was usable and effective for Hmong students' understanding of biology concepts, skills, and science experiences. Based on the results, the usefulness of technology for Hmong student depends on how they perceived the outcome and benefits of the use of the technology. The outcome expectancy of usefulness and ease of use of technology included both cognitive and affective outcomes. The cognitive outcome is enhancing student learning and understanding while the affective outcome is providing hands-on experience, career exploration, task completions, and meeting their instructional needs in a biology environment. Thus, the acceptance of technology for Hmong students is due to outcome expectancy.

Task-Technology Fit

The use of both educational and biology technology is a TTF for Hmong students and has an impact on science learning for Hmong students in biology course. TTF as described by Gu et al. (2013) is the ability of technology to assist students in performing their tasks and to accept technology due to performance improvement and task completion. The findings of this research aligned to TTF of performance improvement and task completion. The results of technology as a fit for the learning needs of Hmong students relates to the TTF of performance. In terms of performance improvement, my finding of performance is consistent with El-Gayer et al.'s (2011) investigation of the influence of tablet PCs in which performance expectancy has a direct influence on Midwest students' acceptance of tablet PCs. In terms of TTF, the results of technology as a fit for relevant course in my study also support the TTF of task completion. The findings of Gao and Wu (2015) confirmed the TTF of task completion where northeastern American students' use of Moodle was found to help them stay on track with classwork as it is a useful tool and is convenient to use.

In terms of technology as a fit for the learning needs of Hmong students, Hmong students indicated that technology is an extension of learning for better understanding of the biology content and is an extension of the learning from the textbook to actual experiments. This finding supports the findings of Gungoren et al. (2014) in that mobile technologies are a fit for the learning needs of students to motivate students, facilitate flexible learning within an education environment, and allow for better time management. The fit for Hmong students is that Hmong students reported performance improvement when using technology to get a better understanding of the content, to make it easier to understand the content, to have a deeper understanding of the materials, and to make learning more meaningful. In addition, teachers reported that the technology they used in class fits the learning needs of Hmong students in which technologies support teaching and learning. The technology supports student learning because students are engaged, it helps students retain content as well as recall information, and dive deeper into the content. The technology supports teaching because it allows students to complete the task given by teachers and teaches them necessary tools for science investigations. Therefore, both student learning as well as better understanding of biology content for Hmong students is a confirmation of the TTF of performance improvement. Similar to the results from my study, data from the study of El-Gayer et al. (2011) indicated that TTF has a positive correlation with students' belief that technology will help attain performance gains in school.

In terms of task completion, Hmong students reported that what technology can do for them is a positive usefulness of TTF. According to Güngören et al. (2014), students' acceptance of technology is important in regards to how they use the technology to fit relevant coursework. In terms of technology as fit for the relevant biology course, Hmong students indicated that technology is a fit to test and acquire data and results. The relevant task-fit of technology in the biology course for Hmong students is the efficient collection of data and automated calculations of results that decreases the time of completing it manually. More importantly, Hmong students believed technology is a task-fit because without technology then they cannot complete their experiments. Shih and Chen (2013) stated that technology adoption depends on how well the new technology fits with the task it supports. Thus, the use of technology is a fit to accomplish what Hmong students needed to do in their biology course. As technology is a good fit for Hmong students in term of the functionality of the technology to support learning and task completion, Kuo and Lee (2011) suggested that a fit for task completion should increase student perceptions of technology usefulness. Results from this study show that it is possible that Hmong students accept technology in terms of TTF and feel it increases their performance, productivity, and task completion.

Overall, Hmong students believed that TTF influenced their acceptance of technology in biology class due to the usefulness of technology to support the learning needs of students and relevant coursework. In addition, teachers believed that TTF influenced Hmong students' acceptance of technology in biology class due to the usefulness of technology to support the learning needs of students and learning content. In other words, Hmong students accept technology for what it is able to do for them.

Thus, the acceptance of technology for Hmong students is influenced by TTF as found in other previous studies as mentioned above.

Social Influence

The literature review indicated that social influence has a positive and significant impact on technology utilization. In this study, the use of both educational and biology technology is a social influence for Hmong students and has a positive impact on science learning for Hmong students in biology course. Social influence as described by Gu et al. (2013) is the ability to perform or not perform a task due to perceived social pressure. Hmong students reported that peer pressure, culture and intracultural differences, and environmental stimuli influenced their usefulness of technology in biology class. Similar to the results of my study, data from the studies of Chen et al. (2013), El-Gayer et al. (2011), Gu et al., and Qin et al. (2011) extends that peer pressure, culture and intracultural differences, and environmental stimuli were reported to have an influence on technology acceptance. Similarly, Attuquayefio and Addo (2014) explored Ghanaian students' behavior toward the acceptance of ICT and found that social influence of teachers and students directly influence technology acceptance. Attuquayefio and Addo (2014) stated that Ghanaian students' use of ICT is due to teachers being helpful in the use of ICT and other students' thinking they should use the ICTs to increase productivity and to get good grade. Attuquayefio and Addo's finding suggest that teachers served as social influence. Thus, similar to Ghanaian students, Hmong students are also influenced by people around them such as teachers and classmates. In terms of peer pressure, attitude toward technology affect Hmong students' belief about the usefulness of technology. Hmong students reported that their friends' attitude affect how they feel about the usefulness of a particular technology. Similarly, Chen et al.'s (2013) study confirmed that Taiwanese students used application of WBI because their friends, classmates, and teachers think they should use the WBI system. In another study by Stets, Brenner, Burke, and Serpe (2017), students think that their friends, family members, partners, and coworkers see them as a science student and in the same way it affects how they see themselves as a science student. Thus, results from my study confirms the social influence of friends, classmates, and teachers on the usefulness of technology as in Chen et al.'s study and Stets et al.'s study.

In addition, Hmong students reported that if their teachers and friends do not use the technology then they will not use it too. This supports studies done with Taiwanese students by Chen et al. (2013) and Ghanaian students by Attuquayefio and Addo (2014), and further extends the impact of peer pressure on technology acceptance. Therefore, the social influence of teachers and friends impact Hmong students' intention to use technology. The connection to literature is that my study's results extend to Hmong student results El-Gayer et al. (2014) found with various Mid-western students. My findings support El-Gayer et al.'s findings in that social influence has been shown to impact a student's intentions and attitudes related to technology use. Results from my study also confirm El-Gayer et al.'s study related to the usefulness of tablet PC's was influenced by the perception of significant others, and students as a user group are more susceptible to social influence over time. Similarly, Chen et al. found that students' use of WBI was influenced by their teacher: "my teacher would think that I should use the

WBI system and I will have to use the WBI system because my teachers require it" (p. 117). Thus, similar to students in El-Gayer and Chen et al.'s study, Hmong students reported that their relationship with others impact their use of technology. This finding confirms the literature of Qin et al. (2011) where northeastern United States students' use of online social networks technology was affected by the number of students using the technology and whether other students think they should use it. For example, Hmong students stated that the support they get from their teachers and peers play a big role in their use of technology where their teachers and peers are able to teach and show them how the technology is important and useful in completing their assignments. Therefore, Hmong students used technology in class because they believed their teachers and peers think they should perform the required tasks with technologies. Overall, Hmong students' use and acceptance of technology is influenced by the social influence of peer pressure.

In terms of culture and intracultural differences, Hmong students believed their first-hand experience and exposure to science via technology affects their learning of science concepts that they do not experience in their home life. The literature review suggested that since Hmong students retain knowledge from their communities and families, they may develop misconceptions of science and technology use (Carpenter-Aeby et al., 2014a; Luong & Nieke, 2013; Mahowald & Loughnane, 2016; McCall & Vang, 2012). It may be possible that intracultural differences may negatively impact Hmong students use of technology. However, the findings from this study does not support a negative impact of student learning. Instead, the findings from this study support Sadeghi et al.'s (2014) findings of Iranian students in that intracultural differences have a significant impact on the beliefs and perceptions of the use of computer technology. While Iranian students reported that uncertainty of technology in the Iranian culture does not allow them to appreciate and treat computers as useful, Hmong students reported that the uncertainty of technology in the Hmong culture does allow them to develop an appreciation for the ability to use technology, which enabled them to experience learning they could not have otherwise. The ability of technology to allow Hmong students to experience learning they could not have experienced was not present for Iranian students in the study of Sadeghi et al. Thus, this finding disconfirms the negative impact of intracultural differences. Also, students added that they grew up in a family that does not believe in science but the use of technology allowed them to develop a belief for science. Similarly, in terms of openness to experience, Hmong students believed that the first-hand experience and exposure to science allowed them to be open to using technologies in the classroom. By being open to technology use, students reported that technology can improve their quality of learning in the biology course when they are able to set up, collect data, and analyze data with technology. In addition, the use of technology at school allowed Hmong students to measure muscle reflexes using probes and sensors that they do not have at home. Although culture is a unique social influence to Hmong learners, the limited use of biology technology in the Hmong culture did not negatively impact Hmong students' use of technology.

In terms of environmental stimuli, El-Gayer et al. (2011) stated that the influence of the environment has been found to relate to the beliefs of the usefulness of technology.

In addition, Kumar, Zusho, and Bondie (2018) added that students develop competence by engaging in meaningful learning tasks in caring and supportive learning environments. The environmental stimuli students believed to impact the usefulness of technology included lack of technologies in the home and societal functions. In terms of lack of technologies in the home, Hmong students reported the lack of technologies at home impacted their beliefs on the usefulness of technology. Initially, students reported that they do not think technologies would be helpful when they are accustomed to completing task at home without technologies. However, students later reported that technologies can really help them get a better understanding of what they are learning and doing in biology class. Therefore, the lack of technologies at home may negatively impact the usefulness of technology for Hmong students but when they realized the importance and benefit of what technology can do for them then they develop an appreciation for the technologies that are lacking in their home environment. An explanation as to why Hmong students believed technologies to be helpful when they are not accustomed to the technology is impacted by environmental learning factors. Results from my study confirm environmental stimuli to be a factor in influence of the adoption and acceptance of tablets for Palestinian students in Khlaif's study (2018). Khlaif's finding is consistent with my findings in that learning environment with technical and instructional assistance services enhanced the adoption and acceptance of tablets in the classrooms. In addition, Khlaif's study further supports this study in that the environment of the classroom with the availability of technical infrastructure supports the adoption and acceptance of tablets. Therefore, having a biology environment of reliable technology ensures that Hmong students will use, adopt, and accept the technologies within the biology environment. Thus, the learning environment was found to be a positive influence for Palestinian students and my study has found that it may also apply to Hmong students. In addition, Hmong students believed that when they are exposed to an environment that supports the use of technology then technology becomes useful. Similarly, Khlaif indicated that the use of tablets in classroom activities will enhance with technical support and be challenged without technical support when technical problems occurs. Also, in biology class, they are exposed to the use of biology technology so the use of biology technology becomes a norm and becomes a part of their classroom function. Hmong students believed that the prevalent use of technology around them creates an environment where technology has become a normal part of how society functions. In addition, the positive experiences of Hmong students with the use of technology confirmed the result of Lin and Lin's (2016) study that the presence of technology in the learning environment resulted in positive experiences for students.

Furthermore, teachers believed environmental stimuli is a social influence impacting the usefulness of technology. The social influences in this study in terms of environmental stimuli included Hmong students' lack of contact with technology, engagement and purposeful usage, and parent expectations of teachers. Therefore, teachers reported that Hmong students were not aware of the usefulness of technology because they have little opportunities to use technology and they lack contact with current technology. Teachers supported the exposure and increase use of technology for Hmong students to foster the usefulness of technology when students lack contact with technology in their home environment. Similarly, Fokides (2017) confirmed that an increased level of access to the type of technology will allow for gained experiences and increase the chances of technology use and acceptance. Thus, even though Hmong students lack contact with technology, Hmong students' experience with technology leads to positive technology usefulness. Although Hmong students experienced limited technology use in their environment, the low level of technology use at home did not hinder their ability to adopt and use technologies in biology class. This finding is consistent with a similar study conducted by Mtebe and Raisamo (2014) where a low level of internet connectivity and inadequate number of computers were not a hindrance factor to adopt open educational resources (OER). Also, teachers believed that with the use of technology in class, when Hmong students are able to connect biology content with what they are physically doing with technology then Hmong students see that technology allows them to efficiently collect, analyze, transfer, and communicate data. In extension, the connection of using technology to support the learning of biology content is technology usefulness. This finding is in line with Fokides' research in supporting the idea that perceived usefulness is a significant determinant of students' intentions to use technology. Thus, Fokides reported that teachers who believed that MUVEs can improve their work, make them more efficient, and are easy to use then they are going to use them. Similarly, teachers who believed that technologies can improve their teaching and the learning of Hmong students will continue to use technology even if Hmong students lack adequate contact with the technologies in the classroom.

Overall, Hmong students believed that social influence impacted their acceptance of technology in biology class due to peer pressure, culture and intracultural differences, openness to experience, environmental stimuli, and relationships with others. In addition, teachers believed that social influence influenced Hmong students' acceptance of technology in biology class due to environmental stimuli. Thus, the acceptance of technology for Hmong students is influenced by social influence.

Personal Factors

The use of both educational and biology technology is a personal factor for Hmong students and has an impact on science learning for Hmong students in biology course. Personal factors as described by Gu et al. (2013) is the technology belief and capability to perform a given task, and the willingness to try out new technologies. Based on the results of the literature review, both self-efficacy and personal innovativeness are associated with positive technology use due to the confidence, competence, and attitudes of both students and teachers.

In terms of self-efficacy in this research, Hmong students' experience with technology and the relevance and commonality of technology support technology self-efficacy, Hmong students believed that as their knowledge and use of the technology improved they had higher self-efficacy toward technology. In addition, Hmong students stated that their experience or technology maturity influenced the usefulness of technology because if they know what the technology is, then it is easy to use and becomes accessible to them. Also, if they have a good experience using technology then it becomes useful to their learning. Thus, students believed that their experience with technology is what allows them to accept technology. These findings of technology usefulness in terms of self-efficacy confirms the finding of Shih and Chen (2013) in that more experienced users of PCs and software see the tools as more useful than less experienced users. Therefore, tool experience and level of use strongly affects perceived ease of use and perceived usefulness. Also, Hmong students reported that their experience with technology builds their confidence in technology use where confidence in using the technology is important. This finding confirms the study of Chen et al. (2013) since students' self-efficacy in terms of confidence supports their use of technology. Hmong students reported that they are confident in using biology technology even if their teacher does not show them how to use it when they have the instructions for reference. Similarly, Chen et al. (2013) found that students are confident of using WBI system even if there is no one to show them how to do it, even if they have only the instructions for reference, and even if they have never used such a system before. Similar to the results from Chen et al.'s study, Li et al.'s (2012) study also confirmed that self-efficacy influences engagement, performance, and satisfaction of technology learning. Similarly, Hmong students reported that their ability to use technology has increased their performance and engagement in class.

In terms of personal innovativeness, Hmong students reported that their willingness to use technology or be open to using technology in biology has impacted their learning and the usefulness of technology in biology course. This finding supports the finding of Ngafeeson and Sun (2015) in which technology innovativeness had a significantly positive effect on perceived usefulness in the implementation of e-textbook.

The impact of technology usefulness included cultural experiences relevancy, performance, engagement, and learning style. In terms of cultural experiences relevancy, when Hmong students were opened to using new technologies in biology class then they were able to use medical technology to help family members with health conditions similar to what they learned in class. The openness to new technology confirmed the result of Ngafeeson and Sun in that students' decision to use a system based on its ease of use is determined by the individual's willingness to try out new technologies. Thus, the usefulness of technology is that Hmong students are provided with the knowledge and opportunity to use what they acquired in their community and "students' willingness to try out new information technologies is a very important determinant of use decisions" (Ngafeeson & Sun, 2015, p. 65).

In terms of performance, Hmong students believed the use of technology helps them learn biology content, makes it easier to understand the materials better, provides a better understanding of what they are learning or doing, and is efficient and effective to use to enhance the materials they learn in class. With an increase to performance, the willingness to use technology also increased Hmong students' engagement in class. In a similar study of digital technologies, Al-Azawei and Lundqvist (2015) found that Iraqi students experienced high degree of satisfaction and perceived usefulness where the use of online learning and blended learning with digital technologies improved learning quality and motivated students toward new technology learning. The findings of Al-Azawei and Lundqvist's study confirms with the findings of this study in that technology support learning performance, engagement, and motivation. In extension, Hmong students reported they are interested in the content of the biology course due to different technologies, they are excited and eager to learn with technology, and they are engaged and participated in all activities using technologies. Overall, Hmong students stated that technologies created a positive experience for them.

In terms of learning style, Hmong students believed their willingness to use technology supports them as visual learners. According to Al-Azawi and Lungvist (2015), learning styles are important to impact academic achievement, learning time, learning patterns, and learner satisfaction. Thus, the learning style of visual learners has a potential influence on the usefulness and satisfaction of technology for Hmong students. Hmong students stated that in order for them to understand a concept, they need to see how it works or need someone to show it to them. The use of technology provided Hmong students with a hands-on experience that supports visual learners. Although the study by Al-Azawi and Lungvist did not target visual learners, the study confirmed that learning styles may significantly affect learner satisfaction where if the technology is in accordance with their learning styles then they will respond positively to it. On the other hand, Hsu (2015) investigated the relationship among Chinese students' perceptual learning styles and technology acceptance of automatic speech recognition-based computer-assisted pronunciation training (ASR-based CAPT), and found that the visual learning style was the most prevalent among Chinese students' use of ASR-based CAPT. Thus, the findings in this study and Hsu's study confirmed that students with visual and kinesthetic learning styles would possibly perceive technology as easier to use and suitable for them. Although Hsu's study supports Chinese students and my study support Hmong students, both studies confirmed visual learning style as an influence to technology use and acceptance. Thus, Hmong students see technology as a great tool to help them see how things work in order to be able to fully grasp their understanding of the concept. For example, students believed that technology is essential in biology course and acts as a bridge in their understanding between the research aspect and the results aspect.

While Hmong students hold various perceptions of personal factors impacting the usefulness of technology, teachers believed culture and intracultural differences, and personal innovativeness are personal factors impacting the usefulness of technology for Hmong students. Sadeghi et al. (2014) confirmed that culture as a personal factor influences beliefs and behaviors toward technology usefulness. The personal factor for culture is that Hmong students are from a community of limited technology where the Hmong people are unable to reinforce or speak about the usefulness of technology due to their own lack of experience. Similarly, the teachers in McCollough and Ramirez's (2012) study initially underestimated the Hispanic students' capability for comprehending science because of their cultural and low socioeconomic backgrounds. Thus, my study supports the findings of McCollough and Ramirez. However, teachers indicated that they do not see culture as a personal factor affecting Hmong students' use of technology. Instead they see Hmong students' culture as an extension of the Hmong community to the scientific community within the biology class. Similarly, teachers in McCollough and Ramirez's study believed that they will be able to successfully teach science to children from minority groups, and minority students can be successful in learning science if the teaching is effective. Similar to McCollough and Ramirez, Rafalow (2018) found that the digital divde at home and at school is shrinking and teachers can use generational similarities and cultural differences to create opportunities for minority students to translate their digital skills into cultural capital at school. In addition, in class, teachers reported that Hmong students are compliant and teachers never had any experiences or cultural objections to using technology. Although Hmong students have limited exposure to biology technology, teachers believed students are capable of using the technologies in biology class with direction and practice. In a similar study, Meyer and Crawford (2015) found that Latino students' initial lack of interconnectedness between their views of school science learning and the scientific enterprise lead them to believe that the science they reported doing in school was entirely different than the views they held. Although my study and Meyer and Crawford's study focused on different ethnic groups, both studies support the involvement of students in authentic science learning and scientific activities via technology to provide a more accurate schema of what scientists do. Furthermore, teachers stated that Hmong students are willing and ready to learn anything. The willingness of Hmong students to use technology is a personal innovativeness. Hmong students' embrace of technology and hands-on activities through the use of technology is because they are willing to try out new technologies in class.

Overall, Hmong students believed that personal factors influenced their acceptance of technology in biology class due to technology self-efficacy and personal innovativeness. In addition, teachers believed that personal factors influenced Hmong students' acceptance of technology in biology class due to technology self-efficacy, personal innovativeness, and cultural and intracultural differences. Thus, the acceptance of technology for Hmong students is also due to personal factors.

Limitations of the Study

The limitations of this study are related to the qualitative research design of case study. The limitations to trustworthiness that arose from execution of this study included transferability, researcher bias, framework, and sample size. The first limitation is related to the transferability of case study results. Although collecting and analyzing data from multiple sources of evidence will strengthen the construct validity of a case study (Yin, 2014), the results of this study may only be transferable to similar populations of Hmong students and teachers found in similar high schools located in other regions of the United States. Likewise, the results of this study may only be transferable to high school biology teachers and students who are involved in other PLTW programs.

The second limitation is researcher bias because my role as the principal researcher accounts for full responsibility over data collection and analysis. However, I used specific strategies to address this potential bias, including triangulation, member checks, and reflexivity. These strategies were presented in Chapter 3 in the section about issues of trustworthiness in relation to qualitative research.

The third limitation is the use of a single conceptual framework, the TAM (Adetimirin, 2015; Gu et al., 2013). The limitations of TAM include the failure to take into social consideration of the use of information technology and system regarding social development, technology enhancement, and social consequences (Adetimirin, 2015). However, Gu et al.'s (2013) version of the TAM was chosen because it includes a social influence component that may address this limitation. Since Gu et al.'s version of TAM did have a social component, it is not a limitation. Also, my study did not call for the use of multiple frameworks so the use of a single conceptual framework is not a limitation.

The fourth limitation is a small sample size. Eight Hmong science students and two science teachers were selected from two classrooms in the same high school, which is a small sample compared to the total students and teachers in the school and district. Data for this study may have been richer if more students and teachers were involved. Also, the small sample size may limit the transferability of this study as the beliefs of the two-embedded analysis group may not represent the beliefs of all Hmong students and science teachers at the high school level.

Recommendations

The recommendations for further research are grounded in the strengths and limitations of this study and the literature review in Chapter 2. Although the literature review support Hmong learners, technology use and acceptance, and perceptions of both educational technology and biology technology, seven gaps were revealed. The first gap is that little is known of Hmong students' perceptions of learning science in biology settings. This study provided an insight into how technology impacts Hmong students' learning in biology but additional research is recommended to provide a better and stronger understanding of Hmong students learning in science setting. The second gap is that there is little research related to how the Hmong use, accept, and perceive biological science and technology use. The data from this study showed some factors that contributed to Hmong students' use and acceptance of both educational and biology technology, but additional research is recommended to provide a more thorough understanding of numerous student and teacher participants. The third gap is that the learning style of Hmong students requires further investigation. This study provided the insight that Hmong students developed a positive experience through hands-on learning and being visual learners. However, this study only provided a small projection of the learning style of Hmong students and additional research is recommended to gain a better understanding of other learning styles that may impact Hmong student learning.

The fourth gap is that there is limited research regarding technology acceptance in high school biology. Although this study provided a perception of Hmong students' acceptance of technology in high school biology, the result is only of a small percentage and additional research is recommended to strengthen the study. The fifth gap is that there is a scarcity of studies pertaining to TTF in high school students in high school biology. Although this study provided a positive TTF for Hmong students in biology class, additional research is recommended to strengthen the study as well. The sixth gap is that there are limited studies on social influence of technology use in high school biology. Although this study indicated that social influence has a positive and significant impact on technology utilization for Hmong students, the study is of a small sample size and additional research is recommended to confirm this theory for additional Hmong students. Lastly, the seventh gap is that personal factors may contribute to technology use for Hmong learners. Although this study reported that personal factors have a positive impact on Hmong students' acceptance of technology and biology learning, additional research is recommended to allow for the transferability and creditability of results. Overall, this study provided both Hmong students' and teachers' perception of technology use in biology course and addressed the gaps in the literature review, but more research is needed to understand the impact of technology innovations in high school biology courses in other schools and districts. The results of this study are consistent with findings in the literature review but the sample size was small, and results are not generalizable to all Hmong students and teachers who are part of the innovative biology course. Thus, more research is needed to better understand the impact of technology innovations in high school biology courses on science learning for Hmong students.

Social Change Implications

The results of this study have implications for positive social change on the individual level, organizational level, and at the societal level. There are also implications related to empirical research that may be done in the future on this topic.

First, the results of this study have implications on the individual level. The significance of this study is determined in relation to improving practice in the field and to contributing to positive social change. The findings provide practical insights for teachers and students in general, but more specifically for teachers of Hmong students, and for Hmong students themselves. This study provided important insight related task-fit studies of biology technology were found in the literature review for PLTW high school science course, when before no study had explored this phenomenon. This study provided a perspective of the TTF of both educational and biology technology to support Hmong students' learning of biology content. This study advanced knowledge of Hmong students' acceptance of technology and biology learning. The key implications of Hmong students' acceptance of technology is that technology usefulness is positive, technology ease of use is easy and positive, impact of technology use is positive, technology acceptance is due to outcome expectancy, personal factors, task-fit, and cultural factors; and technology had a positive influence on learning biology content. Therefore, teachers can use these findings to advance their knowledge of teaching to Hmong students. Teachers' greater acquisition of knowledge for skills to teach to Hmong students may lead to greater acquisition of learning for Hmong students.

Second, the results of this study have implications on the organizational level. This study may encourage science teachers to improve their instruction by using technology to provide personal, hands-on, and relevant learning. In addition, students may receive additional support from their science teachers about how to effectively use technology in science classrooms. Also, teachers will implement more use of educational technology and biology technology to support student learning of biology content. District and school administrators may also provide more effective teacher training in how to improve technology use in science classrooms. School administrators will also need to evaluate their science programs to incorporate technology and to focus on helping both teachers and students become readily willing to take on new technologies. In relation to positive social change, this study has the potential to improve academic experiences in science for Hmong students, and possibly other minority students, in regard to technology use in science classrooms. Hmong students may better understand how to apply technology to solve complex scientific problems. As a result, Hmong students may become more effective problem solvers who can lead their own learning by identifying problems, finding solutions, and testing solutions using innovative thinking and technology. In addition, the use of innovative technology should encourage more Hmong students to enroll in programs such as PLTW to increase their exposure to technology in science. Greater technology exposures in biology classes may lead to greater learning experiences which will boost both Hmong students and their teachers' acceptance and adoption of technology as well as improve biology content learning. The inclusion of innovative technologies will lead to deeper and richer experiences in the science environment and would be helpful in improving students' learning of science through technologies.

Furthermore, the results of this study can be used to design guidelines for Hmong learners or to provide additional learning materials for teachers that have not experienced teaching to Hmong students. Though the number of focal Hmong students included in this study was small, their voices provided a compelling narrative to disentangle what an innovative biology course may mean for Hmong students. Findings suggest that instructional approaches with technology that provided Hmong students with opportunities to experience authentic science learning while being sensitive to the cultural aspects of science as well as different culture or ethnic groups can provide students with important resources for science understandings and science learning.

Third, the results of this study have implications on the larger societal level. An improvement to learning is also an improvement to society. The positive impact of technology on science learning for Hmong students included enhancement of learning and understanding, which leads to improved student performance and outcomes. With technology innovations having a positive impact on science learning of biology content for Hmong students, the impact of technology for Hmong students in this study may lead to a greater impact of technology for the Hmong community. One problem I proposed as a need to conduct this research is that Hmong students still lag behind other ethnic groups in science performance, and the attainment of science degrees remains lower than in other content areas (Xiong, 2010; Xiong & Lam, 2013). Therefore, technology innovations can become powerful catalysts for improving Hmong students' performance in high school biology courses. The improvement in performance indicates that Hmong students are better equipped to go to college and to further advance their education and careers in science. Therefore, Hmong students are using their acquired technology and science skills to serve themselves and their community. With more Hmong students exhibiting greater science academic performance, the performance gap may narrow between Hmong students and other ethnic groups. In this situation, an improvement to Hmong student performance is also an improvement to the Hmong achievement gap, which is an improvement to the Hmong community. In all, an improvement to the Hmong community is also an improvement to society as a whole. Thus, high performing Hmong students are able to go to college, further advance their education, and give back to their community. A better education for Hmong students would guarantee a better society as societal progress is linked to better education where good schools should produce good students who are intellectually developed to take on the challenges of the world and be able to affect changes that surround them.

Furthermore, school readiness and achievement are associated with the kinds of jobs and wages people are able to secure. In the literature review, Hmong learners are impacted socially due to poverty as 25% of the Hmong population lives in poverty (Dung et al., 2012; Pfeifer, 2013) while in Wisconsin, 21% of Hmong students under the age of 18 live in poverty (Pfeifer, 2013). Therefore, an improvement to Hmong students' education is also an improvement to their socioeconomic status where the acquisition of higher education may bring Hmong students out of poverty. Thus, when Hmong students' socio-economic status improve, society's socioeconomic status improves too. In addition, I strongly believe that the success and failure of society is based on its' citizens. A better quality of science experience for Hmong students implied that they should be able to improve their learning. An improvement to learning indicated that there is development to their intellectual, civic, and social skills. Similarly, the success and failure of society is based on its' students. In order to generate a productive society, there is a need for improved citizens. In this situation, an improved citizen is someone who is willing to hold oneself accountable for the well-being of the larger community as a way to build the capacity of more citizens to be accountable and to become creators of the community (Block, 2008). Therefore, when technology innovation is able to shift Hmong students' thinking as they acquire new knowledge so they can make a difference and change the actions of the world then they should be able to make inform decisions and serve as patient problem solvers in their community and society. Thus, the purpose of education is to adequately educate students to make informed choices regarding the status of society. My belief is that truly transformative schools do more than educate students; they empower teachers, engage parents and inspire communities, and educate the mind and the heart of students toward a common goal.

There are also implications related to empirical research that may be done on this topic in the future. This study provided interesting insights into the applicability of some of the relative constructs of TAM, with respect to explaining the outcome expectancy, task-technology fit, social influence, and personal factors of Hmong students in using educational and biology technologies. The research findings suggested general adequacy and applicability of the conceptual framework in the innovative biology setting. This study confirms and extends the literature to include the TAM and Gu et al.'s four predictors of technology use related to Hmong students' intention, actual usage, and acceptance of technology. Furthermore, the findings imply that pedagogues and instructional methodologists must leverage both the advantage of new learning technologies to the reality of student perceptions and use. Students' technology innovativeness should be factored into instructional technology usage decision-making models for biology teaching. In addition, exposure to the technology should be considered as it is likely to moderate students' acceptance of technology use.

Conclusion

The use of both educational and biology technology can be an effective tool in improving teaching and learning in science classrooms for Hmong students. The understanding of the TAM is also an important framework in understanding Hmong students' acceptance of technology. The ability for Hmong students to be exposed to technology not relevant in their community or culture is a way of providing opportunities for Hmong students to be successful in science classrooms. To support all learners in the classroom and especially Hmong students, exploring ways to improve the teaching of science or biology concepts and content through the use of technology is an important skill that is vital for research and the advancement of society. Before this study was conducted, no studies explored the impact of technology innovations on science learning for Hmong students. Also, no studies explored the technology acceptance of technology to have an impact on biology learning through analysis of outcome expectancy, TTF, social influence, and personal factors. This study contributes research evidence on how high school science teachers perceive the impact of technology innovations on science learning for Hmong students, and how Hmong students perceive their own learning of science with technology. The purpose of this study was to describe how technology innovations in high school biology courses impact science learning for Hmong students based on a TAM. Results indicated that Hmong students' acceptance of technology aligns with Gu et al's (2013) construct of outcome expectancy, TTF, social influence, and personal factors as outlined by the TAM model. In addition, results of this study indicated a positive usefulness of technology, positive ease of use of technology, and a positive impact of technology on biology learning for Hmong students. Therefore, Hmong students' positive experience of technology usefulness, ease of use, and biology learning contributed to their acceptance of technology innovations. It is critical that educational stakeholders support biology teachers in the acquisition and implementation of technology to provide quality and engaging instruction to all learners. The benefit of technology innovations is improved teaching and learning for all students.

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Appendix A: Letters of Cooperation

May, 2017

Dear Mr. Thai Xiong,

Based on my review of your research proposal, I give permission for you to conduct the study entitled *The Impact of Technology Innovations in High School Biology Courses on Science Learning for Hmong Students* at two high schools in this school district. As part of this study, I authorize you to contact the principals and potential student and teacher participants at these schools in order to conduct individual teacher and student interviews and to ask participants to maintain reflective journals for a short period of time. I also authorize you to ask teacher and student participants to review the tentative findings of this study for credibility. Individuals' participation will be voluntary and at their own discretion.

We understand that our organization's responsibilities include providing you with the use of a conference room, classroom, or resource room at the high school in order to ensure privacy for the interviews and to provide documents related to this innovative biology course as requested by the researcher. We reserve the right to withdraw from the study at any time if our circumstances change.

The student will be responsible for complying with our site's research policies and requirements, which includes submitting a Letter of Assent and a Letter of Consent to the researcher. The district does not require the researcher to submit these letters to the district.

I understand that the researcher will not identify our organization in the dissertation that is published in Proquest.

I confirm that I am authorized to approve research in this setting and that this plan complies with the organization's policies.

I understand that the data collected will remain entirely confidential and may not be provided to anyone outside of the student's supervising faculty/staff without permission from the Walden University Institutional Review Board (IRB).

Sincerely,

[redacted]

Appendix B: Letter of Support

May 2017

Dear Mr. Thai Xiong,

Based on my discussion with you about your research study, which is titled *The Impact of Technology Innovations in High School Biology Courses on Science Learning for Hmong Students,* I agree to support implementation of this study at our high school.

I understand that this research study will include the following requirements for selected biology teachers, Hmong students, and the principal:

- Selected Hmong students and biology teachers will participate in a 30 minute individual interview in a private room at the high school during non-instructional hours.
- Selected Hmong students and biology teachers will complete four reflective questions after the interview that may take up to 30 minutes.
- Selected students and biology teachers will return the reflective questions responses to the researcher within 2 weeks from the interview date in a pre-paid envelope.
- The principal will send group results on end-of-course assessments for the innovative biology courses to the researcher as soon as possible.
- Selected biology teachers will provide relevant course documents (course descriptions and standards alignment, sample unit plans, and sample lesson plans) to the researcher if available.

I understand that my organization's responsibilities include providing Thai with the use of a conference room, classroom, or resource room at the high school in order to ensure privacy for the interviews and to provide documents related to this innovative biology course as requested by the researcher. We reserve the right to withdraw from the study at any time if our circumstances change.

Sincerely,

[redacted]
Principal
[redacted]

May 2017

Dear Mr. Thai Xiong,

Based on my discussion with you about your research study, which is titled *The Impact of Technology Innovations in High School Biology Courses on Science Learning for Hmong Students,* I agree to support implementation of this study at our high school.

I understand that this research study will include the following requirements for selected biology teachers, Hmong students, and the principal:

- Selected Hmong students and biology teachers will participate in a 30 minute individual interview in a private room at the high school during non-instructional hours.
- Selected Hmong students and biology teachers will complete four reflective questions after the interview that may take up to 30 minutes.
- Selected students and biology teachers will return the reflective questions responses to the researcher within 2 weeks from the interview date in a pre-paid envelope.
- The principal will send group results on end-of-course assessments for the innovative biology courses to the researcher as soon as possible.
- Selected biology teachers will provide relevant course documents (course descriptions and standards alignment, sample unit plans, and sample lesson plans) to the researcher if available.

I understand that my organization's responsibilities include providing Thai with the use of a conference room, classroom, or resource room at the high school in order to ensure privacy for the interviews and to provide documents related to this innovative biology course as requested by the researcher. We reserve the right to withdraw from the study at any time if our circumstances change.

Sincerely,

[redacted]
Executive Director
[redacted]

Appendix C: Letter of Invitation

Dear Potential Teacher Participants,

My name is Thai Xiong and I am a Ph.D candidate at Walden University, which is an accredited institution of higher learning by the Higher Learning Commission. I am also a school administrator in a northeastern school district. I am conducting a research study about the impact of technology innovations in high school biology courses on science learning for Hmong students. I am honored to invite you to participate in this study because you are a biology teacher and a Project Lead The Way (PLTW) master teacher at your school.

The division of research and evaluation at central office has approved this study because it is aligned with district goals and strategies, and the high school principal has also given me permission to conduct this study. Attached is a consent form that explains the data collection process.

If you are interested in participating in this study, please sign the attached consent form and return it to me in the enclosed self-addressed, stamped envelope at your earliest convenience. I will select the first two teachers who return signed consent forms to me. Thank you for your consideration of this research study.

Sincerely,

Thai Xiong
PhD Candidate
Walden University

Dear Potential Student Participants,

My name is Thai Xiong and I am a Ph.D candidate at Walden University, which is an accredited institution of higher learning by the Higher Learning Commission. I am also a school administrator in a northeastern school district. I am conducting a research about the impact of technology innovations in high school biology courses on science learning for Hmong students. I am honored to invite you to participate in this study because you are a Hmong student enrolled in a Project Lead The Way (PLTW) biology course.

The division of research and evaluation at central office has approved this study because it is aligned with district goals and strategies, and your high school principal also gave me permission to conduct this study. Attached is a consent form for parental permission to participate in the study and an assent form for student permission to participate in the study if you are under 18 years. The forms also explain the data collection process.

If you are interested in participating in this study, please sign the attached forms and return it to me in the enclosed self-addressed, stamped envelope at your earliest convenience. I will select the first four students who return signed consent or assent forms to me. Thank you for your consideration in the participation of this research study.

Sincerely,

Thai Xiong
PhD Candidate
Walden University

Appendix D: Student Interview Questions

Student Interview Questions

1. What types of technologies do you use in your biology course?

2. Why do you believe that these technologies are or are not useful?

3. Why do you believe these technologies are or are not easy to use?

4. How do you believe that your experiences with these technologies have impacted your learning in biology class?

5. What factors do you believe influence your acceptance of technology in biology class?

6. What factors do you believe influence your learning of biology content when you use technology?

Appendix E: Teacher Interview Questions

Teacher Interview Questions

1. What technologies do you use in your biology course?

2. Why do you believe that these technologies are or are not useful?

3. Why do you believe these technologies are or are not easy to use?

4. How have your experiences with these technologies impacted Hmong student learning in biology classes?

5. What factors do you believe influence Hmong student acceptance of technology in biology classes?

6. What factors do you believe influence Hmong student learning of biology content when they use technology to assist them?

Appendix F: Student Reflective Journal Questions

Student Reflective Journal Questions

1. How does the technology that you use in your biology course reflect what you are expected to learn?

2. How does the technology that you use in your biology course fit the task requirements for the content you are expected to learn?

3. What social influences do you believe reflect your beliefs about the usefulness of technology for this biology course?

4. What personal factors do you believe influence your beliefs about the usefulness of technology in this biology course?

Appendix G: Teacher Reflective Journal Questions

Teacher Reflective Journal Questions

1. How does the technology that you use in your biology course reflect your expectations for student outcomes?

2. How does the technology that you use in your biology course fit the task requirements of the content you are expected to teach?

3. What social influences do you believe reflect Hmong students’ beliefs about the usefulness of technology in this biology course?

4. What personal factors do you believe influence Hmong students’ beliefs about the usefulness of technology in this biology course?

Appendix H: Document Data Collection Form

Course Document Data

Source: Date:

Document Data Collection Form	
Criteria	**Content Analysis**
Purpose	
Organizational structure	
Content	
Use	

Appendix I: Transcription Confidentiality Agreement

CONFIDENTIALITY AGREEMENT

Name of Signer: ____

During the course of my activity in transcribing collected audio data for this research: "The Impact of Technology Innovations in High School Biology Courses on Science Learning for Hmong students" I will have access to information, which is confidential and should not be disclosed. I acknowledge that the information must remain confidential, and that improper disclosure of confidential information can be damaging to the participant.

By signing this Confidentiality Agreement I acknowledge and agree that:

1. I will not disclose or discuss any confidential information with others, including friends or family.
2. I will not in any way divulge, copy, release, sell, loan, alter or destroy any confidential information except as properly authorized.
3. I will not discuss confidential information where others can overhear the conversation. I understand that it is not acceptable to discuss confidential information even if the participant's name is not used.
4. I will not make any unauthorized transmissions, inquiries, modification or purging of confidential information.
5. I agree that my obligations under this agreement will continue after termination of the job that I will perform.
6. I understand that violation of this agreement will have legal implications.
7. I will only access or use systems or devices I'm officially authorized to access and I will not demonstrate the operation or function of systems or devices to unauthorized individuals.

Signing this document, I acknowledge that I have read the agreement and I agree to comply with all the terms and conditions stated above.

Signature:_____________________________________ Date: ____________

Appendix J: Data Use Agreement

DATA USE AGREEMENT

This Data Use Agreement ("Agreement"), effective as of May 1, 2017 ("Effective Date"), is entered into by and between **Thai Xiong** ("Data Recipient") and [redacted] ("Data Provider"). The purpose of this Agreement is to provide Data Recipient with access to a Limited Data Set ("LDS") for use in research in accord with the HIPAA and FERPA Regulations.

1. Definitions. Unless otherwise specified in this Agreement, all capitalized terms used in this Agreement not otherwise defined have the meaning established for purposes of the "HIPAA Regulations" codified at Title 45 parts 160 through 164 of the United States Code of Federal Regulations, as amended from time to time.

2. Preparation of the LDS. Data Provider shall prepare and furnish to Data Recipient a LDS in accord with any applicable HIPAA or FERPA Regulations

Data Fields in the LDS. **No direct identifiers such as names may be included in the Limited Data Set (LDS).** The researcher will also not name the organization in the doctoral project report that is published in Proquest. In preparing the LDS, Data Provider or shall include the data fields specified as follows, which are the minimum necessary to accomplish the research: ***End-of-Course Assessment***.

3. Responsibilities of Data Recipient. Data Recipient agrees to:

    a) Use or disclose the LDS only as permitted by this Agreement or as required by law;

    b) Use appropriate safeguards to prevent use or disclosure of the LDS other than as permitted by this Agreement or required by law;

    c) Report to Data Provider any use or disclosure of the LDS of which it becomes aware that is not permitted by this Agreement or required by law;

    d) Require any of its subcontractors or agents that receive or have access to the LDS to agree to the same restrictions and conditions on the use and/or disclosure of the LDS that apply to Data Recipient under this Agreement; and

    e) Not use the information in the LDS to identify or contact the individuals who are data subjects.

4. Permitted Uses and Disclosures of the LDS. Data Recipient may use and/or disclose the LDS for its research activities only.

5. Term and Termination.

    a) Term. The term of this Agreement shall commence as of the Effective Date and shall continue for so long as Data Recipient retains the LDS, unless sooner terminated as set forth in this Agreement.

    b) Termination by Data Recipient. Data Recipient may terminate this agreement at any time by notifying the Data Provider and returning or destroying the LDS.

    c) Termination by Data Provider. Data Provider may terminate this agreement at any time by providing thirty (30) days prior written notice to Data Recipient.

    d) For Breach. Data Provider shall provide written notice to Data Recipient within ten (10) days of any determination that Data Recipient has breached a material term of this Agreement. Data Provider shall afford Data Recipient an opportunity to cure said alleged material breach upon mutually agreeable terms. Failure to agree on mutually agreeable terms for cure within thirty (30) days shall be grounds for the immediate termination of this Agreement by Data Provider.

    e) Effect of Termination. Sections 1, 4, 5, 6(e) and 7 of this Agreement shall survive any termination of this Agreement under subsections c or d.

6. Miscellaneous.

    a) <u>Change in Law.</u> The parties agree to negotiate in good faith to amend this Agreement to comport with changes in federal law that materially alter either or both parties' obligations under this Agreement. Provided however, that if the parties are unable to agree to mutually acceptable amendment(s) by the compliance date of the change in applicable law or regulations, either Party may terminate this Agreement as provided in section 6.

    b) <u>Construction of Terms.</u> The terms of this Agreement shall be construed to give effect to applicable federal interpretative guidance regarding the HIPAA Regulations.

    c) <u>No Third Party Beneficiaries.</u> Nothing in this Agreement shall confer upon any person other than the parties and their respective successors or assigns, any rights, remedies, obligations, or liabilities whatsoever.

    d) <u>Counterparts.</u> This Agreement may be executed in one or more counterparts, each of which shall be deemed an original, but all of which together shall constitute one and the same instrument.

e) Headings. The headings and other captions in this Agreement are for convenience and reference only and shall not be used in interpreting, construing or enforcing any of the provisions of this Agreement.

IN WITNESS WHEREOF, each of the undersigned has caused this Agreement to be duly executed in its name and on its behalf.

DATA PROVIDER

Signed: ________________________

Print Name: ____________________

Print Title: _____________________

DATA RECIPIENT

Signed: ________________________

Print Name: ____________________

Print Title: _____________________