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Beliefs and Practices of High School Science Teachers on the Integration of Technology-Based Assessments in the Classroom

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Beliefs and Practices of High School Science Teachers on the Integration of Technology-Based Assessment in the Classroom

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Abstract

As more schools begin to phase in technology to classrooms, teachers are faced with a new task. Technology-based assessments allow teachers and students to get immediate feedback on the level of understanding of a certain topic. Using the Technological Pedagogical Content Knowledge (TPACK) framework gives insight to the knowledge base of teachers in various categories. A survey was conducted with Minnesota high school science teachers on their perceptions and practices of implementing technology-based assessments in their classrooms. Data analysis showed a difference between the beliefs and practices of teachers in their use of this type of assessment. Participants described a number of barriers and changes to integrating technology-based assessments in their classrooms including access, time, training, and software. The data suggests that more training and access is needed for technology-based assessments to be utilized to their full capacity in secondary science education.

Introduction

With the recent influx of technological advances to help benefit society, technology is becoming more and more integrated into the everyday life of the average person. Laptops, tablets, and cell phones are now able to perform many tasks. Pursuing different career options, creating innovative inventions, and even navigating the outdoors is easier now because of technology. These platforms are becoming less expensive and faster to help the increasingly global world. A survey conducted by Pew Research Center in 2017 found that nearly 77% of Americans own a smartphone. Technology allows people to connect from all over the world, create novels, and design the next popular video game. The amount of jobs that involve technology has also increased immensely over the years as well. There are companies that focus

solely on creating new pieces of technology to help people. For example, the application Uber helps people find car rides using only their smartphones. In some situations, technology has made tasks easier and faster for society.

Exposure to the technological devices is starting at increasingly younger ages. A survey by the National Center for Education Statistics in 2015 found that 94% of children ages 3 to 18 had access to a computer at home. It is not uncommon to hear of a toddler playing on an iPad. As these tools become more and more intertwined with society, people must be able to use them effectively. While some applications are mainly used for entertainment, others can make teaching faster and easier. The purpose of school is to prepare kids to have the skills they need to succeed in life. Students need to learn how to read, write, solve math problems, develop complex understandings of how our society came to be, describe an observed phenomenon using science, and how to express themselves in the arts. Now, more than ever before, technology is also intertwined with all of those content areas. As a society, we must teach children skills regarding technology to set them up for productive and meaningful lives after their schooling is complete.

That teaching of technology begins with teachers. In recent years, many schools assign students a technological device and are becoming “one-to-one” with technology. One-to-one (1:1) refers to when a technological device is provided by the school for each student (Great Schools Partnership, 2013). Since there have been so many new websites and applications to help students learn material, these devices allow students to use those new tools to their full potentials. Some schools allow students to take the device home to complete assignments, and other students check them out at school during specific classes. Often there is a contract that students must sign stating that they will take care of the device and that if there are damages, the student will then be fined. Elementary and middle schools tend to have iPads or tablets for their

students. High schools tend to have laptops for their students to use because they have more complex tasks to accomplish. When teachers utilize these tools in an effective way, they are helping students to become more prepared for our technologically advanced society.

In addition to managing technology, teachers must keep in mind a variety of components while creating lessons for their students. Teachers must start their lesson with an anticipatory set to hook their students in to the topic for the day. This hook should engage and excite the students in relation to the unit they are studying. Teachers also have a set of objectives for students to accomplish through their lesson activities where they build up their knowledge and later apply their skills (Chiappetta & Koballa, 2015). Some form of an assessment is used to check for student understanding. These assessments help teachers to see if there are concepts that still need clarification and highlight any major misconceptions in their thought process that may need correcting. Next, teachers close their lesson by restating the major takeaways for the students. While planning the lesson, teachers also must make accommodations for their students. Differentiation ensures that all students are being challenged, regardless of their original level of understanding (Chiappetta & Koballa, 2015). Other students may need further support if they are English Language Learners (ELL) or have an Individualized Education Plan (IEP). All of these aspects are important for each lesson that a teacher develops and enacts. Throughout this lesson planning process, different pieces of technology can be intertwined to enhance the overall quality of the lesson. An anticipatory set, for example, could include a starter question about what the students want to be when they grow up. Students then respond anonymously with their laptops or cell phones and their answers are displayed for the whole class to see. Another technological tool for science teachers comes in the form of online laboratory activities. These labs give students examples of real-world science experiments that may not be feasible to perform in a high school

setting. Overall, lesson planning can include a variety of technological additions to enhance student learning.

Assessments in education take on many different forms. There are formal assessments like typical exams that teachers use to see how their students are learning the material. These can include summative assessments that test students on how well they understand the entirety of a unit or course (Chiappetta & Koballa, 2015). In Minnesota, each year students take summative assessments in the content of math and language arts. Science tests are given in grades 3, 5, 8, and 10. (Minnesota Department of Education, 2018). Other forms of assessments in education include informal assessments. An example of this can be as simple as having the teacher walk around the classroom to ask students clarifying questions (Chiappetta & Koballa, 2015). Formative assessments are assessments that are done during instruction to check for student understanding and help teachers cater instruction to students' developing knowledge (Chiappetta and Koballa, 2015). Examples of this style of assessment include posing questions to students while they are learning. Assessments provide teachers, schools, districts, and the state with data so that their students can be objectively compared to one another. This data can also help education professionals to implement changes in standards, teaching methods, or testing practices in order to help students learn content in the best way possible.

Technology-Based Assessments

Because of the increase of technology use in schools, teachers are now intertwining technology into their lesson plans. Assessments in particular have been reinvented with the creation of many internet-based assessments developed by educators and application designers.

These websites and applications can help teachers to incorporate assessments into their lesson plans.

There are endless possibilities when it comes to these technology-based assessments. Many helpful educator websites have lists explaining the basic features of these tools. These lists can help teachers compare similar applications to determine which one is best for their classroom and for the type of assessment they want to have. One such list was compiled by Common Sense Education (2019) in their top technology list of formative assessments to use. One application on that list is called Flipgrid, which is a performance-type assessment. It has students video record themselves using the camera feature on their device while talking about a certain topic. EDpuzzle is another application that has teachers insert questions into a YouTube video. The questions pause the video to check the understanding of the student on the information they just watched. Pear Deck is another website that uses interactive slides in a presentation to check a student's understanding during a lecture. Kahoot! is a web-based review game where students play against each other to answer questions as fast as they can correctly. There are also traditional online test platforms where students answer multiple choice questions through a Learning Management System (LMS) such as Canvas or Schoology. A majority of these technology-based assessments allow for immediate feedback for both the students and teacher on how well the student is comprehending the material. These sites are also engaging and often have a competitive nature to them which entices students to do well. However, technology-based assessments may take a considerable amount of time to figure out exactly how to operate the program and how to help students if they have troubles with it too. Other times these internet-based assessments may stop working as a result of glitches or wireless internet connection

problems. These examples of technology-based assessments have their own advantages and disadvantages for various age levels and content areas.

Purpose of Thesis

The purpose of this thesis was to survey high school science teachers on their beliefs and perceptions of integrating technology-based assessments. Many teacher preparation courses stress the importance of utilizing these technology devices. Educators are also taught that some type of an assessment should be included in each lesson as a way to see how much their students actually learned that day. As the United States Department of Education (2015) explained, there are a variety of advantages when discussing technology-based assessments. This style of assessment can be embedded directly into learning to help students check to see how well they are understanding the material. Students and teachers then receive real time feedback which can help catch any misconceptions early on (Department of Education, 2015). There is also the possibility of assistive technology with technology-based assessments. Students with special needs, such as having a visual impairment, can use a text-to-speech program to aid in their assessment completion which could not be done on an individual scale without the use of technology. Other students with special needs can utilize assistive technology like bilingual dictionaries while completing an assessment. By incorporating these assistive technologies into the already digital assessment, the students can receive the help they need without being singled out as needing that extra assistance in front of the class. Teachers tend to understand the importance of assessments in lessons but the idea of having technology incorporated in the lesson is more of an afterthought. As Edutopia (2007) explained, technology integration will be most successful when it becomes a routine for students and flows naturally throughout the

lessons. This will keep students actively engaged in the ideas for the lesson. Technology in schools and the accessibility that is now present with these devices is relatively new. This means that teachers are having to learn along with their students the best way to use these in their lessons. Some schools have regular training for their teachers to keep up to date on technology changes while others do not.

The goal of the research was to see if there is a difference between the beliefs and practices of high school science teachers in their implementation of technology-based assessments. If there was a difference between them, the study aimed to highlight the barriers that some teachers faced when integrating technology-based assessments into their lessons along with providing suggestions for future implementation. The ultimate purpose of educating children is to prepare them for the world outside of school and these technology-based assessments may help students gain the skills they need to be productive members of society in the future.

Technological Pedagogical Content Knowledge Framework

One well-known theory in the realm of technology and education is the Technological Pedagogical Content Knowledge (TPACK) framework developed by Mishra and Koehler in 2006. This framework explains how teachers should be taught to interweave the broad field of technology into their instruction with their students. While this theory was developed thirteen years ago and technology of our current society is much more advanced than before, there are many aspects of this framework that are still relevant today. An update to this framework was conducted in 2009 by Koehler and Mishra. They explained that many teachers still do not have the experience that they need to have in order to feel confident in their technology skills. Koehler

and Mishra (2009) also emphasized that the TPACK framework does not give one set way to intertwine technology into education. The most successful way to do so would be to look at the needs of the teachers, needs of the students, and the subject being taught. By looking at these specific categories, the technology integration strategies will be more relevant and applicable to the teachers. The TPACK framework will continue to aid in the research in technology in the education field for years to come.

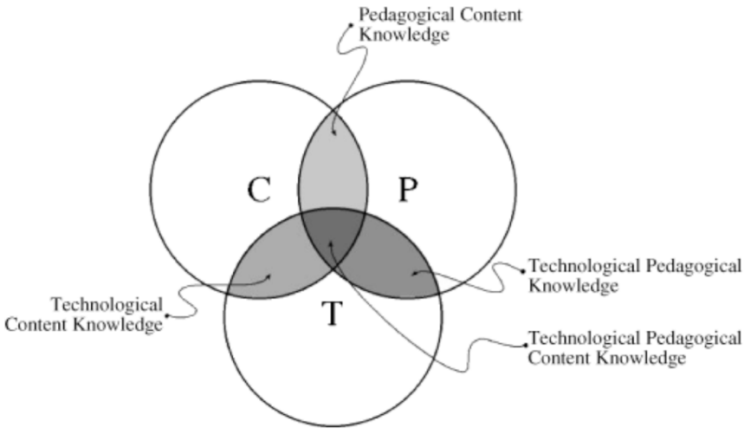

Figure 1. TPACK Model developed by Mishra and Koehler (2006).

Mishra and Koehler (2006) broke up the framework into parts in order to better analyze how each piece influences the other. Using a Venn diagram (Figure 1), they demonstrated the relationship between technology, pedagogy, and content knowledge. These three areas feed off of one another and help to develop teachers into passionate, knowledgeable, and creative individuals. The TPACK framework directly informs many teacher education programs with a pathway towards developing their teacher candidates into successful teachers.

The first part of this framework involves TK, which is technology knowledge (Mishra & Koehler, 2006). Teachers must understand how to operate and find technology that is available to

them. In many schools, teachers are given their own laptops to use. These laptops have applications that teachers must be able to navigate successfully. With the importance of the Internet, teachers must have a reliable internet connection at their homes in order to practice their skills as well. These skills include how to send emails, use search engines, create word documents, develop presentations, and analyze spreadsheets. Since people will likely use these skills in future careers, the skills should be developed early in high school.

Another large portion of this framework involves PK, which is pedagogical knowledge (Mishra & Koehler, 2006). These are the concepts that make people become effective teachers. Many teacher preparation programs have classes designed to help their teacher candidates develop this type of knowledge. Teachers must understand the various theories and ways that a child's mind develops. Other skills in this area include strategies for lesson planning, classroom management strategies, developing relationships with students, and higher order questioning techniques. With these concepts in mind, teacher candidates will become effective teachers that are ready to adapt to any challenge that may arise in their own classrooms.

The third large portion of this framework involves CK, which is content knowledge (Mishra & Koehler, 2006). This piece of the framework focuses on how comfortable the teacher is with the subject matter they are teaching. Teachers must know facts, concepts, evidence, theories, and big ideas related to their field of study. Most teacher preparation programs highlight this with many courses related to the subject of the teacher candidate in question. Once the teacher is confident in their knowledge of the subject matter, they will then be able to convey those ideas to their students.

The technology, pedagogy, and content knowledge areas all influence each other in the framework developed by Mishra and Koehler (2006). The intersections among these three big

ideas create more specific categories that the researchers focused on as a way to help prepare teachers for their time in the classroom.

Pedagogical content knowledge (PCK) is another concept in which teachers must be well versed (Mishra & Koehler, 2006). This idea involves teaching practices specific to the teacher candidate's field of study. In the realm of science, this would involve teaching students about proper lab safety, how to create models, incorporating real world applications into the current subject, and vocabulary that is not simply memorization. One of the biggest ideas in science pedagogy is the importance of keeping lessons inquiry-based (Chiappetta and Koballa, 2015). Hands-on lab activities are also stressed in this field as a way to help students connect, sometimes abstract, concepts into phenomenon they can physically observe. Teacher preparation courses generally have this in the form of pedagogy specific courses such as science pedagogy and art pedagogy. This gives teacher candidates direct instruction and lesson planning related to their content area to prepare them for later on.

Technological content knowledge (TCK) is another intersection that occurs in this framework (Mishra & Koehler, 2006). This area focuses on the technology that is used in the specific subject matter of the teacher. For science, this includes technology that research scientists use to conduct experiments and perform tests. These experiments will help students to apply the knowledge that they are learning in school to real life applications. An example of this can be seen in biology when learning about genetics. The skills and equipment that are needed to perform a gel electrophoresis to analyze DNA are part of the content knowledge that teachers should know. This knowledge can be relayed to students as a hands-on exercise which helps them understand a realistic application of the procedure. This type of knowledge is mainly learned by teacher candidates in the courses related to their specific field of study.

Technological pedagogical knowledge (TPK) is another intersection that occurs with this framework (Mishra & Koehler, 2006). This area focuses on how teachers intertwine technology with their teaching strategies in general. Many schools use online platforms such as Schoology or Canvas to link content and schedules for the class. Teachers must be well versed in how these platforms work to use them to their full potential. There are a variety of other technological tools teachers can use to enhance their teaching such as EDpuzzle, Kahoot!, Flipgrid, and Peardeck. This specific area of technological pedagogical knowledge is one in which teacher preparation programs may be lacking.

According to Gronseth et al. (2010), there are various ways that these programs incorporate technology education to prepare future teachers. Some have stand-alone courses that are focused on technology skills and technology integration. Others focus on incorporating technology into many different courses throughout a whole program. Gronseth et al. (2010) surveyed teachers from various programs and found that it was not necessarily the style of the teacher education program, but the topics that the course covered that mattered most. The most important topics listed were how to use technology to support goals tied to standards, technology to aide in professional growth and teaching computer literacy, and how to use assistive technology in the classroom to aid students with special needs. Another study conducted by Voithofer (2005) described a partnership between a university and a local public school. The course described in this research intertwined service learning with technology education. Preservice teachers were partnered with a practicing teacher to connect their technology content to a real-world experience. This was a required stand-alone technology course at the university. The preservice teachers described how grateful they were for an authentic classroom experience to practice using the technology they were learning. A third course was described by Nguyen et

al. (2016) on the integration of 1:1 technology in a preservice teacher course. These preservice teachers rented or bought an iPad to further enhance their own note taking and organizational skills. The thought process behind this style of course was that teachers are now expected to use technology in classes so by having this similar mindset in their undergraduate course, they would be more comfortable in their own classrooms later on (Nguyen et al., 2016). Changes should be made to some of these preparation courses so that teachers learn valuable information that will last them throughout their teaching careers. These courses will enhance the TPK of teachers which would make them more confident in their TPACK skills and more likely to use technology in their classrooms.

With the research and theory that Mishra and Koehler reviewed, they developed the all-encompassing framework of TPACK (2006). These researchers stressed the importance of looking at these knowledge categories as a whole and not solely as separate entities. Technology should not be simply added as an after-thought when a teacher candidate is preparing for their own lessons. In order to effectively incorporate technology into the classroom in a way that will be most beneficial to students, teachers must constantly remind themselves of these specific knowledge pieces as described by Mishra and Koehler (2006).

Challenges for Teachers and Technology in the Classroom

Teachers have many responsibilities in their own classrooms. They must worry about attendance, student behavior, grading, assessments, meetings, lesson planning, and more. Often teachers will have to prioritize some of those responsibilities over others in order to meet pending deadlines. Using technology is often another task that teachers are given to include in their lesson plans as school districts implement 1:1 programs and expect teachers to use those

devices. With a number of other tasks teachers must accomplish, this piece gets pushed lower on the list of things to do. The challenges with technology integration involve many different areas. The effort it takes to learn how to operate these various applications is extensive. Technology changes so rapidly with our ever-developing society and dedicating that effort to learning how to operate the application may seem like a waste of time if it will be vastly different in the coming years. This effort could be used elsewhere to accomplish a number of other duties that teachers have.

Erduran and Ince (2018) conducted a case study on the difficulties that high school math teachers had with integrating technology into their classes. They analyzed the preparation, implementation, and reflection that five teachers completed with regard to one lesson. They found that if a certain piece of technology did not work, the teacher quickly moved on to completing that part of the lesson without technology. For example, one teacher was using an interactive board, but the cursor froze. She tried to fix it for a couple minutes but then quickly shifted the students' attention to the white board where she continued the example problem. The next time she taught the lesson, she skipped using the interactive board altogether because in the past it did not work properly for her. Time is so valuable in the classroom so many teachers adapt and adjust their lessons if something goes wrong. These researchers also found that if teachers were lacking in technology knowledge (TK), then all the other areas of the TPACK framework were affected negatively as a result. The five teachers in this case study also had anxiety related to discovering how to operate certain software and devices. Erduran and Ince (2018) suggested that schools provide specific training for teachers in order to lessen the amount of anxiety that some may be experiencing. Another suggestion they offered was the importance of using technology at every stage of the teacher preparation program. In some programs,

technology is talked about in multiple courses and in others there is an actual course dedicated to technology integration (Gronseth, et al. 2010). Ensuring the effectiveness of the topics and methods of instruction for this type of course is crucial for preservice teachers to develop confidence in their abilities. When teacher candidates are taught about technology as an add on to their already perfected lesson plan, they will then continue with that same mindset with their future classrooms. As the TPACK framework has explained, these knowledge categories must be continuously looked at as a whole in order to best prepare teachers to implement their technology tools effectively.

Another study by Lee, Feldman, and Beatty (2012) was conducted examining the barriers teachers faced while integrating technology. Their study focused on formative assessment using classroom response systems, such as clickers, so that teachers were able to get immediate feedback on their students' level of understanding. Math and science teachers were the focus group for this study. After interviews and surveys, the researchers created a list of challenges that teachers faced with the classroom response systems. The biggest hurdle identified by most teachers was not having enough time. This time was needed for the teachers to determine how to operate the system and how to introduce this new technology to their students in their specific disciplines. Teachers also explained that they often did not have the technology support that they needed to solve any technological problems that arose in a timely fashion. Lee, Feldman, and Beatty (2012) also concluded that teachers face curriculum pressures which cause them to divert their attention to covering all the necessary material instead of working through the kinks of the technology systems. The researchers suggested that additional training in specific disciplines is needed so that teachers can spend less time figuring out technology problems on their own.

Educational Technology Studies

The field of educational technology is large and ever expanding. Teachers can use technology throughout many different portions of their lessons. While there are some challenges that these teachers face, the best way to understand the thought process of teachers with technology integration is by using a survey or conducting interviews. This style of data collection helps researchers to analyze trends to make this process more seamless.

A study was performed by Chai et al. (2011) on the integration of information and communication technology (ICT) in teaching. ICT includes the use of laptops, phones, internet, and applications. Their original observations showed that ICT was not used often. If it was used, the primary use was to convey information to students instead of facilitating the development of students' knowledge in the content area. Chai et al. (2011) used the TPACK framework to develop a survey to better understand the relationship between all the sub-categories the TPACK framework entails. The survey used by Chai et al. (2010) drew upon other surveys conducted in this field to create a 46-item questionnaire with statements that specifically tied to each of the TPACK subfields of TK, PK, CK, TPK, TCK, and PCK. The survey was deemed the best way to collect data because the goal of this study was to determine the personal views that each teacher had in regard to ICT in their classrooms.

Another study by Koh, Chai, and Tsai (2014) found that teachers were not using their technological devices to their fullest capacities and they sought to determine what was causing this lack of technology inclusion in classrooms. Previous research had shown that the age, technological knowledge, and pedagogical knowledge influenced the beliefs of the teacher in their own TPACK values. Koh, Chai, and Tsai (2014) created a survey that focused on items surrounding the TPACK framework but also added some additional questions related to the

teacher themselves. These items included gender, age, and teaching experience. They wanted to see if any of those factors influenced the perceptions teachers had about implementing technology into their lessons.

A third study was developed by Hsu, et al. (2017). Their focus was on the TPACK framework and teachers. However, these researchers specifically examined gaming technology instead of the larger field of general educational technology. Technology is now becoming a broad field with many sub categories including assessments, interactive labs, and games. Their goal was to see differences teachers had in beliefs, motivations, and confidence related to game-based technology and how to use it in the classroom effectively. In order to specifically target gaming technology, they developed their own TPACK-G questionnaire. When discussing beliefs, motivations, and confidence that teachers have, there are factors that influence these such as age, gender, and teaching experience. In the survey that Hsu et al. (2017) created, they included questions related to those influences in order to more determine the effects they may have had on the teacher.

While these studies used surveys to conduct research on educational technology, they did not specifically look at technology-based assessments. By adapting questions from these surveys and adding other items focused more closely to this thesis, some information can be gathered from high school science teachers on their beliefs and practices of technology-based assessments.

Technology-based Assessment Studies

With the advances that society has made, there are many new websites and applications that teachers can use to collect feedback. As mentioned earlier, these technology-based

assessments vary extensively from large class quizzes to individual video recording. Some of these applications fit the needs of certain disciplines better than others. Each technology-based assessment comes with its own set of limitations as well.

One study was conducted on the application Nearpod by Dunbar in 2016. This type of technology-based assessment would only apply to schools that are 1:1. Nearpod allows the teacher to share presentations to their students' devices. The students can then not move ahead in the presentation but follow along as the teacher walks them through the slideshow. There are various styles of slides that can be used that are interactive. These slides have students complete a task and the answers that the students develop are sent to the teacher's device where they can then be analyzed. The data from the class can be stored as well. Teachers can use open-ended questions, quizzes, polls, and drawing as a way to see the level of understanding that their students have with the material. Dunbar (2016) explained that this technology-based assessment tool was easy to use and create. She used Nearpod in her music classes and she found that the students enjoyed the interactive aspects of the slides. She was able to keep her students engaged in the content, even if it was a presentation style lesson.

Another study was conducted about by Beatty and Gerace (2009). These researchers were examining Classroom Response Systems (CRS). CRS uses polls to have students select their answers which are then sent to the teacher's screen. The teacher can then analyze what the students responded with. This allowed all students to participate in the questioning process. After analysis of past studies, the researchers determined that the use of a Question Cycle would help teachers to understand how to incorporate technology into their lessons best. First, teachers should pose a challenging question to their students that they may not be able to answer immediately. Students should then be given time to ponder the question. Afterwards, the students

would select their answer using the CRS to collect responses. In small groups or a large class, the students should then share their explanations as to why they chose the answer that they did. Students then discuss their answers to figure out which response makes the most sense. The teacher then moderates this discussion and then summarizes the key points that were made in the discussion. This sequence of events would help teachers understand how to implement their technology-based assessments into their classes (Beatty and Gerace, 2009).

In summary, the literature surrounding technology and teaching is largely focused on the TPACK framework as a way to organize and understand the various knowledge bases that teachers must know. The TPACK framework reinforces the idea that technology should be integrated and thought of at all points throughout the preparation of educators. When one type of knowledge is lacking, the others tend to be not well developed as a result. Technology-based assessments are relatively easy to use once teachers become comfortable with their features. This style of assessment allows teachers and students to receive immediate feedback on their understanding of different material. With this in mind, teachers also face various challenges in the integration of technology to their classrooms. The literature focuses heavily on training for teachers during their teacher preparation courses and through professional development while working at a school. The training is most useful when it is specific to the age group and subject matter that is taught. Even with this training, some teachers still face barriers to the implementation of technology because of time constraints and the constant pressure to focus on other aspects of teaching like classroom management and building relationships with students. After analyzing the literature, some questions began to form. What do high school science teachers think about technology-based assessments? How do they use them in their classrooms? If they do not, what barriers are causing them to not utilize this resource? This topic is important

because schools are becoming more and more technology-based. Teachers should feel empowered to utilize these devices to enhance learning for their students and prepare them for the world outside of high school. The hypothesis for this thesis is that high school science teachers believe that technology-based assessments are beneficial to help students understand where they are at in their level of understanding. However, with the endless tasks that teachers must accomplish in a typical school day, technology integration is not on the top of the list of things to accomplish. Time and training are hypothesized to be the top barriers that teachers face while implementing technology-based assessments as evidenced by the literature analyzed for this thesis.

Method

Participants

The participants in this study were high school science teachers. Research was conducted to find high school science teachers in the state of Minnesota. Based on information listed on school district websites, a list was compiled with the names and email addresses associated with various high school science teachers. A total of 107 high school science teachers were emailed a short paragraph describing the purpose of the study and a corresponding link to the survey to complete if they chose to do so. At the start of the survey, the teachers read through a consent form to allow their information to be used in this study. The responses were then kept anonymous and the participants were given two weeks to fill out the survey. The districts that were originally emailed the survey link were from central and southern Minnesota. Of the 14 school districts that were contacted, 93% were public school districts and 7% were private school districts. Since the responses were kept anonymous, there was no way to determine which

teachers from which school districts actually completed the survey. A total of 78 high school science teachers responded to the survey with a response rate of 72%.

The demographic questions that were answered by the participants helped to understand the background on these high school science teachers. Beginning first with the gender of the participants, 47.4% of the responses were female and 52.6% were male. According to the National Center for Education Statistics in 2016 in public schools, 64% of high school teachers as a whole were female and 36% were male which is a considerable difference from the results of the information collected from this survey. The participants in this survey were also specifically in the science field. For their teaching experience, 38.5% taught for 20 or more years, 15.4% taught for 15-20 years, 15.4% taught 10-15 years, 10.3% taught 5-10 years, 14.1% taught 3-5 years, 5.1% taught less than three years, and 1.3% taught only 1 year. This suggests a somewhat diverse range of teaching experience among the participants. With regard to their level of education, 59% had their master's degree plus additional credits, 16.7% had only their master's degree, 20.5% had only their bachelor's degree, and 3.8% chose "other" as their level of education. Lastly, 83.3% of teachers worked in a school with a 1:1 level of technology whereas 16.7% did not.

Materials

For this thesis, the goal was to analyze the perceptions and practices that science teachers had in regard to technology based-assessments. Researchers Mishra and Koehler (2006) developed their TPACK framework and from that theory others have developed their own studies on how to implement this framework into the real world. A variety of those studies were analyzed in preparation for this thesis.

With the literature that was reviewed for this thesis in mind, the development of a survey was chosen as the source of data collection for this thesis. The survey was created using items designed by Chai, et al. (2011), Koh, et al. (2011), and Hsu, et al. (2017). The questionnaire contained twenty items in total. The items instructed the participant to use a Likert scale to convey their agreement or disagreement with the statement. Some of the statements were tied to the TPACK framework and its sub-categories. Other statements involved the beliefs, confidence, motivation, and practices teachers had about technology-based assessments in their classrooms. The teachers responded to these statements using the Likert scale again to show their agreement or disagreement. There were a few statements tied to training that teachers may have had in the use and implementation of technology-based assessments through their school districts. A series of multiple-choice questions involved collecting information on the demographics of the participants as well. These questions included gender, teaching experience, level of education, and access to technology in their school. The final three questions were open-ended and asked teachers to explain the barriers they may have faced and the changes they would suggest to make the implementation of technology-based assessments seamless (Appendix).

Results

The participants that responded to this survey represented a relatively equal ratio of male versus female teachers. There were a variety of levels of teaching experience and education as well. Regarding the implementation of technology in schools, a majority of science teachers have a 1:1 technology program in the schools that responded to this survey.

The first set of questions (Table 2, 1-7) asked teachers to state their agreement or disagreement of various statements related to the TPACK framework of knowledge categories.

Each question was specifically tied to one of the types of knowledge in TPACK including TK, CK, PK, TPK, TCK, PCK, and TPACK. The range for these levels of agreement ranged from strongly agree (5) to strongly disagree (1). The general trend for all of these answers was that the highest percentages were found to be 5 and 4. The median rating for these was 5 or 4 as well. This helps to emphasize the concept that while the TPACK framework does break down the various forms of knowledge into sub-categories, they influence each other greatly. The data showed a consistency in the answers when looking across all the types of knowledge. That trend in consistency implies that the answer the candidate chose for one statement related to TPACK was generally the same for the other statements.

Question type	Strongly agree (5)	Agree (4)	Neither agree nor disagree (3)	Disagree (2)	Strongly disagree (1)	Median Rating
1. TK	46.2%	42.3%	5.1%	5.1%	1.3%	4
2. CK	48.7%	46.2%	2.6%	0.0%	2.6%	4
3. PK	56.4%	42.3%	0.0%	1.3%	0.0%	5
4. TPK	38.5%	48.7%	10.3%	1.3%	1.3%	4
5. TCK	33.3%	52.6%	10.3%	3.8%	0.0%	4
6. PCK	50.0%	44.9%	2.6%	1.3%	1.3%	4
7. TPACK	29.5%	61.5%	7.7%	1.3%	0.0%	4

Table 2. Percentages of agreement or disagreement of teachers on statements related to the TPACK framework. *

The next set of questions (Table 3, 8-12) asked teachers about their training, confidence, motivation, beliefs, and practices related to technology-based assessments. Again, teachers answered by agreeing or disagreeing with the statements made. The median answer for the statement about having training on how to use technology-based assessments was a 4. Teachers also generally had confidence in their ability to use technology-based assessments in their classroom as seen by the highest percentage of a 4. For the motivation category, teachers overall

agreed that during planning, they think about how to incorporate technology-based assessments into their lessons. However, there was a shift with the last two items in the table. The belief question asked candidates if they believed that teachers should use technology-based assessments at least once a week in their classrooms. The median answer for this question was a 3. The practice question asked candidates whether they actually used technology-based assessments at least once a week in their classrooms. This shows that teachers generally did not feel a strong agreement or disagreement with this statement.

Even though teachers generally had the knowledge as evidenced by the TPACK statements, they still were not always planning to include technology-based assessments in their lessons. Teachers have many duties and little time to complete them all during a school day. Specifically incorporating technology-based assessments may not be high priority on their list of things to do so their motivation may be low (Table 3, 10). High school science teachers were unsure about whether or not they should be using technology-based assessments in their classrooms at least once a week (Table 3, 11). Because of the variety of levels of teaching experience, this conclusion seems accurate. More experienced teachers may have a set way of how they informally or formally assess students that in the past did not need technology. Other teachers may be interested in discovering new ways to receive feedback on how well their students are comprehending the material.

While teachers may be unsure if they should be using these technology-based assessments, the actual practice of teachers using them is quite different. More teachers answered a 5 and a 4 than a 2 and a 1 about their practice in the classroom (Table 3, 12). This trend suggests that teachers either use technology-based assessments in their lessons often, or they do not use them much at all. To conclude, the difference in the percentages between the beliefs and

practices of teachers shows that there must be something that caused teachers to be unsure if they should use them in their lessons or not. To get a glimpse as to what that something might be, the open-ended questions about barriers and challenges helped to possibly explain why this disconnect occurred.

Question type	Strongly agree (5)	Agree (4)	Neither agree nor disagree (3)	Disagree (2)	Strongly disagree (1)	Median Rating
8. Training	16.7%	46.2%	16.7%	12.8%	7.7%	4
9. Confidence	25.6%	50.0%	14.1%	5.1%	5.1%	4
10. Motivation	20.5%	35.9%	14.1%	20.5%	9.0%	4
11. Belief	12.8%	19.2%	48.7%	11.5%	7.7%	3
12. Practice	21.8%	28.2%	11.5%	28.2%	10.3%	3

Table 3. Percentages of agreement or disagreement of teachers on statements related to training, confidence, motivation, belief, and practice.

The last two questions in the survey were optional and open-ended. The candidates were asked to explain their opinions on barriers they encountered and changes they would make to technology-based assessments. The answers were then categorized into groups in an effort to better analyze the trends. Candidates often wrote about more than one barrier or change, so each idea was noted. Focusing on the barriers (Figure 4), the most common answers were access, time, cheating, and slowness of the technology. With the changes (Figure 5) suggested by teachers, the most common answers were training, time, software, and access. The idea of access included not having a 1:1 program established in the school, the device not being charged, and not having access to Wi-Fi at home.

Beginning with the responses on the barriers of technology, access was the most common answer given (Figure 4). Even though some schools may have a 1:1 program, the survey respondents still considered access one of their barriers to using technology-based assessments.

Candidates described how students may have a device, but they often come to school with it not charged so using it can be a challenge. Another teacher described how some of her students have limited access to Wi-Fi at home because they are in transient housing or are homeless. Some students have also lost or broken their devices, so they are not able to use them in the classroom. This answer in particular brought up an important point about technology. Even though much of society has shifted their thoughts to the digital age, not everyone is able to use new technologies because of their home lives or financial situations. Expecting all students to have a reliable Wi-Fi connection at all times outside of school is not feasible for most school districts. If a student does not have a device that is charged and working, they will not be able to complete any assessments that require technology. This would be a huge hurdle in the implementation of technology-based assessments in schools.

The next most common barriers listed by the candidates were time and cheating. Teachers need more time to understand how to use the applications and to edit the technology-based assessments to fit to their needs. With more time, they could dedicate part of their lesson planning into critically looking at how to incorporate this style of assessment into their lessons. Cheating can happen on almost all types of assessments. Using a device to complete an assessment also means that students are able to use other resources to look up answers easily such as the search engine Google. This can cause problems in that the assessment may only be determining how easily and quickly a student can use the internet to find the answer instead of the knowledge they have learned in class.

Figure 4. Breakdown of barriers to technology-based assessments as listed by high school science teachers.

Moving to the changes that teachers suggested, training and time were the two most popular answers (Figure 5). As new applications and aides to technology are developed, teachers need to be trained on how to use these new features. Teachers spend their days at school teaching students, not being trained on how to use technology. However, in order to incorporate these technology-based assessments successfully, the training must be sufficient for all teachers. They will then be more likely and more confident in their abilities to use them. For example, if teachers have the skills to troubleshoot their technology problems quickly, they would be more likely to take risks and try to implement technology into their lessons.

Time is valuable to everyone including teachers. They all spend their days with their students, as well as, developing engaging lessons and creating classroom environments that are safe and welcoming. With limited time, it seems that aspects like the integration of technology-based assessments are deemed less important and are pushed aside. If given more time, teachers would be able to learn how to best use this technology for their discipline.

The next most common answer for a change to integrating technology-based assessments was about software. With all the applications in the world, there is often a free version and a paid

subscription. The free version for some applications allows adequate features to be accessed. However, other applications charge teachers to use their best services. For example, with the website EDpuzzle, teachers are able to store 20 videos related to their content. In order to get more storage, teachers must pay a monthly fee. Some websites have deals for schools to purchase subscriptions to certain applications. However, many schools are already short on money so dedicating more funds to technology can be a difficult situation. Other software pieces include ways to prevent cheating. A feature called LockDown Browser freezes a student's screen to only be on the assessment they are completing. This helps to prevent cheating because students cannot simply use search engines to find the correct answer to a question. LockDown Browser technology has an annual fee based on the number of students at the school. The minimum payment is $2,795 per year for 1,000-2,0000 students (LockDown Browser, 2019). With schools constantly trying to raise money to help support their students in any way they can, they must be selective about where the funds will go. There are more needy causes that would benefit from more money, such as school supplies, than security for technology-based assessments to eliminate cheating.

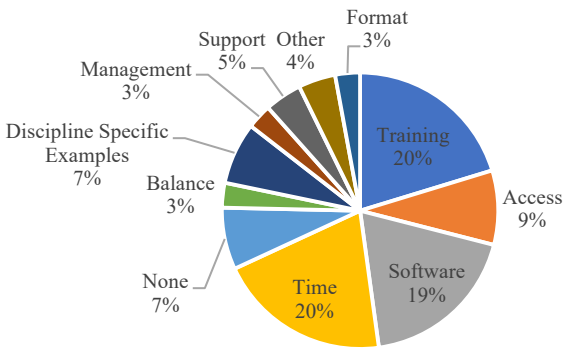

Figure 5. Breakdown of changes to make incorporating technology-based assessments easier as listed by high school science teachers.

Discussion

Based on the data collected from the surveys on high school science teachers in Minnesota, they generally have the knowledge to implement technology-based assessments in their lessons according to the TPACK framework. However, when looking at the emotions and feelings associated with integrating this style of assessment, the candidates were more unsure about their place and use in the classroom. The major barriers listed in responses were access, cheating, and time. The major changes suggested by the teachers included more training, better software, and more time as well.

The research conducted for this thesis added to the existing field of educational technology. After analyzing the current literature, there were many articles surrounding the broad field of technology and the beliefs teachers have surrounding its use. By creating a survey with questions based on the TPACK framework (Mishra & Koehler, 2006), the data supported the idea that all of the various knowledge pieces work together to create the all-encompassing technological pedagogical content knowledge. If a candidate was confident in one knowledge category, they generally had the same feeling in the other related categories. Koh, Chai, and Tsai (2014) used questions in their survey related to demographics like age, teaching experience, and gender. Like the results concluded in that study, the results from this thesis showed no real difference in the answers from candidates related to their demographics. However, this framework describes technology as a whole, not the individual tools that make it up. This thesis instead focused on specific use of technology in creating assessments. This type of assessment can seamlessly be intertwined to lesson planning to enhance the overall learning of the students. The applications that are used in school settings are also changing daily so this thesis adds a current analysis to the barriers associated with technology integration.

The study conducted by Lee, Feldman, and Beatty (2012) showed that one major barrier to technology integration by teachers was time. Teachers struggled to find time in their busy schedules to incorporate technology into their lessons. This was one of the major barriers that the candidates responded with in the survey conducted for this thesis as well. Erduran and Ince (2018) also found that specific and adequate training was needed for teachers to feel confident in their technology integration skills before they would be willing to actually incorporate them into lessons. The candidates that responded to this survey also highlighted content-based training as a suggestion to help assist in the transition of technology integration. However, one barrier that this survey found that was not highlighted by any of the literature analyzed for this thesis was access to technology for all students.

The research gathered through this thesis supported the literature in the field of educational technology. However, this thesis is centered on the implementation of technology-based assessments specifically. Technology-based assessments provide teachers and students with immediate feedback related to the content they are studying. With the variety of applications that can be utilized to see how well students are understanding material, technology-based assessments can be easily included in lesson plans. While some teachers may already be seamlessly including this style of assessment, other teachers may not. The barriers that these teachers face include time and training which was supported by the literature analyzed for this thesis. However, the barrier of access to technology for all students was highlighted by the candidates but was not mentioned as a major factor in the literature. With these conclusions, some suggestions for future changes can be explained.

Future Implications

Because of the results of the survey responses, teachers appear to have training on technology-based assessments, yet they still want more. The format of teacher in-service and workshop varies from school to school. Often there is a school wide presentation on some aspect that will help make teachers more effective at their jobs. With the older students, teachers are able to design content for higher level thinking. The types of technology-based assessments that fit seamlessly for one content may not be applicable for another content. A school wide training on technology-based assessments would not be helpful for high school teachers. Training on technology-based assessments would be most helpful to high school teachers if the training was specific to each discipline. Teachers can work in a group with individuals who are striving to cover the same state standards as they are and can then share what types of assessments work best for them. Teachers must also be updating their training on technology-based assessments frequently. There are new and better applications that are developed regularly that may be even better than the websites that are currently being used. Technology is ever changing in society and schools should be keeping their teachers up to date with it as well in order to prepare their students for the real world.

Training on technology-based assessments can also take place in teacher education programs. The TPACK framework (Mishra & Koehler, 2006) explained that all of the sub-categories feed off of each other. This means that when teachers candidates are learning how to become excellent teachers, they should also be learning how to incorporate technology into their classrooms. At the high school level, teacher candidates must also be learning in depth concepts related to their content. It is important, again, to be knowledgeable about how technology and the content area intersect. Gronseth et al. (2010) explained that it is not necessarily important which style of technology education program is used but that the content is specific and taught

effectively to the preservice teachers. This can be in the form of a stand-alone course or the integration of technology throughout the teacher preparation program. With more exposure to technology, teacher candidates will be more likely to use technology in their own future classrooms. The upcoming teachers will then be comfortable navigating applications and websites to find the best tool they need. As confidence with using technology increases, teacher candidates will then be able to use technology-based assessments in their classes with ease.

Access to technology was also an issue that many high school science teachers explained in their responses. While many schools have technology at a 1:1 level, others do not. In order to increase the use of implementation, school districts must have a device for each student to use. Having that device does come with its own set of responsibilities. As described in the survey responses, students often forget to bring their device to school or they bring it with the need to charge it. This creates a problem for teachers if they want to create a technology-based assessment since not all students could then complete the assessment. Classrooms must come equipped with charging ports for students to use if they forget to charge their device. This would solve the problem of having low battery issues. Classrooms also must come equipped with extra devices on hand to ensure that all students are able to complete the assessment online. These changes would cost the school districts money, but they would help students and teachers accomplish those tasks. Other students may not have Wi-Fi available at home so accessing the technology-based assessments away from school may not be an option. In these circumstances, teachers and the school building's open hours must be flexible. If schools are open earlier and stay open later, a student that does not have internet access at home may be able to come early before school or stay after to complete an assessment online if they have transportation. Teachers can also be flexible in their lesson planning by creating time in class for students to complete

technology-based assessments to ensure that all students are able to have access. Not everyone has easy access to technology and a reliable Wi-Fi connection at home so schools must accommodate to the needs of all their students.

Limitations

This thesis had some limitations in the conclusions that it was able to draw. First, since the primary data collection method was a survey, the researcher was not able to ask why a candidate responded the way they did. Interviews would have allowed participants to elaborate more on their answers to get a more wholistic view of these ideas. A self-report, like the survey used in this study, may yield different results than an actual observation that a researcher may conduct. The survey also lumped all types of assessment (formative, summative, formal, and informal) together into one category of assessments. High school science teachers may use technology-based assessments for one or all of the categories. Since there are so many different uses, it would have been best to differentiate between the various types of assessments in the survey to get a more accurate representation of the perceptions of high school science teachers.

Importance

As our world becomes more connected with technology, schools are following suit. Students are often given technological devices to aide in their education. While these tools can be used for a number of purposes, various forms of assessments have been created through different applications. This study highlighted various tools that teachers can use for assessments in their classrooms such as EDpuzzle and Flipgrid. It also focused on high school science teachers and the barriers they are specifically facing in their integration of technology. In the

realm of educational technology, it is important to look at the context in which the students are being taught. The age of students indicates which types of assessments are at their appropriate developmental level. There are specific assessments that may be more useful in certain subjects as well. By looking at this specific set of teachers, recommendations were made to help these teachers overcome their obstacles in the future. The barriers this study highlighted will be important to change for the future so that teachers are more willing and confident in their technology implementation skills. Schools should prepare students to lead successful lives after graduation. In this current technologically infused society, being able to effectively operate a device will be an important skill for all students to learn. As teachers confidently incorporate technology into their lesson plans, students will gain those skills and experiences.

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Appendix

Technology-Based Assessment Survey

***Acronyms listed in parentheses after each question were omitted for the survey that participants completed.

1. I have the technical skills I need to use technology. (TK)
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

2. I have various ways and strategies of developing my understanding of science. (CK)
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

3. I can assess student learning in multiple ways. (PK)
    a. Strongly agree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

4. I think critically about how to use technology in my classroom. (TPK)
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

5. I know how to use technology to better develop my understanding of science. (TCK)
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

6. I am able to use different teaching strategies to effectively teach science to my students. (PCK)
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree

e. Strongly agree

7. I can teach lessons that appropriately combine science, technologies, and teaching approaches. (TPACK)
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

8. I have been trained on how to use technology-based assessments in my classroom.
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor strongly disagree
    d. Agree
    e. Strongly agree

9. If I received training on technology-based assessments, I would use technology-based assessments more in my classroom.
    a. I already have sufficient training and I do use technology-based assessments.
    b. I already have sufficient training and I do not use technology-based assessments.
    c. I do not have sufficient training but if I had more training, I would use technology-based assessments.
    d. I do not have sufficient training but if I had more training, I would not use technology-based assessments.

10. I am confident in my abilities of understanding and utilizing technology-based assessments. (Confidence)
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

11. When I prepare my teaching plans, I link curriculum to technology-based assessments. (Motivation)
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

12. I believe that high school science teachers should use technology-based assessments in their lessons at least once a week. (Belief)
    a. Strongly disagree
    b. Disagree

c. Neither agree nor disagree
d. Agree
e. Strongly agree

13. I use technology-based assessments in my lessons at least once a week.
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

14. What is your gender?
    a. Male
    b. Female
    c. Other

15. How many years have you been teaching high school science?
    a. This is my first-year teaching
    b. Less than 3 years
    c. 3-5 years
    d. 5-10 years
    e. 10-15 years
    f. 15-20 years
    g. More than 20 years

16. What is your level of education?
    a. Bachelor's degree
    b. Master's degree
    c. Master's plus credits
    d. Other

17. Does the school that you currently work at provide technology for their students on a 1:1 level (example: each student has been given an iPad or laptop)?
    a. Yes
    b. No
    c. Unsure

Optional Questions:

18. What if any barriers have you had in implementing technology based-assessments into your classes?
19. What changes could be made to make the process of incorporating technology-based assessments easier for you?
20. Any other additional comments or suggestions?

*Table 2

1. Technology knowledge (TK)

2. Content knowledge (CK)

3. Pedagogy knowledge (PK)

4. Technological pedagogical knowledge (TPK)

5. Technological content knowledge (TCK)

6. Pedagogical content knowledge (PCK)

7. Technological pedagogical content knowledge (TPACK)