Identifying Components of a Hypothetical Assessment of Digital Literacy for Tennessee Students

by

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Abstract

Technology is constantly becoming more important in the daily lives of people worldwide. With this ever-increasing importance, it is imperative that the education system can adjust to educate their students about the world that they are entering. In Tennessee, a new senate bill that attempts to close the gap between STEM interest and STEM performance will require students to have one year of a computer applications course before they can graduate. In this thesis, I propose a method for assessing the efficacy of this policy change to its goal by identifying potential components of an assessment of digital literacy skills. To accomplish this goal, I analyzed nine different international experiments of digital literacy through the lens of a European framework, DigComp. The results concluded that the ideal way to assess digital literacy is through a format that includes a combination of multiple choice questions and interactive simulations.

Table of Contents

INTRODUCTION 1
- Background 1
- Purpose of Study 3
- Thesis Statement 3

LITERATURE REVIEW 4
- ICT Literacy 4
- DigComp Framework 6
- Implications for the United States 9

METHOD 10
- Research Method 10
- Method of Source Analysis 11

RESULTS 12

DISCUSSION 14
- Principle 1: Information and Data Literacy 14
- Principle 2: Communication and Collaboration 16
- Principle 3: Content Creation 17
- Principle 4: Safety 18
- Principle 5: Problem Solving 20
- Generalizations for Tennessee 20

CONCLUSION 26
- Study Summary 26
- Limitations 27
- Implications for Practice 27

References 28

Table of Figures

Figure 1: DigComp Framework Summary 7

INTRODUCTION

Background

In 2023, technology is more of a necessity for day-to-day life than ever, and this increase in importance shows no sign of stopping in the immediate future. Jobs in computer science are becoming more popular and are clear points of interest for upcoming generations. However, there is a disconnect between the education that students are receiving and the jobs they want to pursue. In 2020-2021, 48 percent of students who took the ACT expressed interest in a STEM career but only 28 percent of those students met their STEM benchmarks (Ragland-Hudgins, 2023). This demonstrates a disconnect between the education students are receiving and the jobs that they want to pursue. To prepare its students for the technological world, the public school system must respond in a way that educates its students in the art of technology.

It is no secret that jobs in STEM fields (Science, Technology, Engineering, and Math) are becoming more prevalent throughout time (Arstorp, 2021). The European Union aims to have doubled its technology specialists by 2030; however, they have not specified the intended actions to achieve this goal (Molnar et al., 2022). If students are to eventually adjust to a workforce that is reliant on "technology specialists", the emphasis on technology should begin in their classroom education. For that to occur, teachers must feel supported and incentivized to be digitally literate and incorporate these skills into their classroom (Chen et al., 2022). Teachers who are technologically proficient are more likely to leave the education system and look for other opportunities due to lack of support from their governments (Molnar et al., 2022). Denmark has taken

the lead in making students more aware of the opportunities that come from STEM education by increasing incentives and access to technology in primary and lower secondary schools (Arstorp, 2021).

The state of Tennessee recently proposed a statewide curriculum change to incorporate technology into all levels of public schools. According to Public Chapter 979 on computer science, students who will begin high school in 2024 will be required to receive credit for a computer science class, and this class will be able to replace a credit for the third science or the fourth math. The Tennessee Department of Education is trying to make this adjustment as simple as possible for educators by offering grade-specific curriculum and computer science standards as well as providing them with a free-of-charge pathway for educators to pursue endorsement in computer science if they so choose (S.B. 2406, 2022). Hopefully, this will lead to students with more digital literacy, which means that they will be able to use technology to effectively communicate with others and accomplish tasks.

After Covid-19 identified many of the areas where school systems were lacking in their technical infrastructure, policy changes to incentivize its repair were inevitable. Policymakers are anxious to reform schools to increase STEM education; this is evidenced by S.B. 2406 in Tennessee. S.B. 2406 will require high school students to take one year of computer science coursework, which will be able to count as the third science or the fourth math for the student. This will

begin with the graduating class of 2028 (S.B. 2406, 2022). This change to making a basic STEM education compulsory is only the beginning. The next step will be developing a standard method of assessment.

Purpose of Study

Nationally, there has never been a consensus on how to assess whether or not a student is digitally literate (Ba et al., 2002). Tennessee is unprecedented in its policy and curriculum changes, but there is no assessment to determine whether or not this instruction and policy change has been effective. Therefore, this study seeks to answer the following research questions:

1. What research has been done in other countries around the world to test ICT literacy?
2. What principles should be included in an assessment of technology skills in Tennessee to address the efficacy of the technology curriculum?

Thesis Statement

Using experimental assessments of ICT literacy from other countries, a performance test with which Tennessee can test the results of Public Chapter 979 and its effect on the development of technology skills of its students can be developed.

LITERATURE REVIEW

ICT Literacy

What is ICT Literacy?

ICT literacy, or digital literacy, refers to the ability to use digital technologies to manage, evaluate, gather, and learn information about society (Khlaisang & Koraneekij, 2019). The range of skills encompassed by the term includes many subtopics including proficiency with various online platforms, such as coding or AI, and digital citizenship. Digital citizenship is using technology responsibly and cooperatively (Zook, 2023). Similar to the concept of good citizenship, digital citizenship refers to upholding a certain degree of intrapersonal values when using technology. Research shows that students are gaining more ICT skills and Internet exposure outside of the classroom than in it. Martin Senkbeil conducted a study in 2023 to quantify the effect that students' home learning environment (HLE) has on ICT literacy and finds a significant relationship between the two (Senkbeil, 2023). Therefore, inside the classroom, the goal of technology education curriculum should focus on refining these skills that students' are already exposed to in early adolescence.

ICT Literacy in Education Worldwide

In 2020, the COVID-19 pandemic led to the shutdown of the majority of schools across the world for a minimum of a couple of months. This sudden shift to solely e-Learning led to the exposure of many shortcomings of the technological infrastructure of multiple school systems. For example, in Germany,

before the pandemic, many educators reported that they had no intention of implementing technology into their classrooms, and none of them were using technology to its full potential (Paetsch et al., 2023). Because the German education system was not prepared to handle such a crisis, there was no certainty of the efficacy of online schooling. Germany was not alone in this.

Depending on the pre-existing level of technology-based learning curriculums, countries had differing capabilities to respond to the sudden need for online education. Some countries, such as Slovakia and Norway, had been incorporating technology into their curriculum for some time. In 2022, a conference in Slovakia regarding ICT literacy celebrated its twentieth anniversary and reflected on the effect that increased digital literacy had prepared the nation for the pandemic (Molnar et al., 2022). The 2006 Norwegian Knowledge Promotion made it one of the first countries to ever include digital skills as one of the five foundational skills of the national curriculum (Arstorp, 2021). Countries like these were able to adapt more quickly and effectively when schools began to close in March of 2020.

The times seem to be changing. A survey conducted of K-12 educators in China showed that most educators in the Sichuan province report having digital self-efficacy, digital literacy, and the intention to implement technology into their classrooms (Chen et al., 2022). The same survey also yielded results showing that those who have less teaching experience tended to be more willing to add technology to their daily routine (Chen et al., 2022). Something similar was also observed in Germany following the pandemic that younger teachers, who had

positive experiences during the pandemic, are much more likely to incorporate technology into their classroom than their more experienced colleagues (Paetsch et al., 2023).

Therefore, as this trend continues, governments around the world will likely begin to shift focus to educating teachers on technology and incentivizing them to be digitally literate. Norway introduced a new teacher professional curriculum, which revolves around technology education, called professional digital competence (PDC). This was introduced in the government through the New Competence Model (Arstorp, 2021). The Philippines have also adopted a similar concept by being more intentional in educating teachers under a digital competencies framework (Cabaron, 2023). Overall, the primary conclusion is that teachers must feel support from their governments and their schools in order to strengthen the technical infrastructure of a school (Paetsch et al., 2023).

DigComp Framework

For policymakers to be moved to change pre-existing systems, there must be empirical results from assessments that demonstrate that an action has made an impact. European countries have developed a framework that encompasses the principles of technology education called the Digital Competences (DigComp) framework (Siddiq et al., 2016). The framework is divided into five primary principles, which are information and data literacy, communication and collaboration, digital content creation, safety, and problem solving, and twenty-one competencies that fall within these areas (Wuerffel, 2017). Expanding upon these five foundational categories are the proficiency levels and the examples of use within employment and learning (Carretero et al., 2017).

Figure 1: DigComp Framework Summary

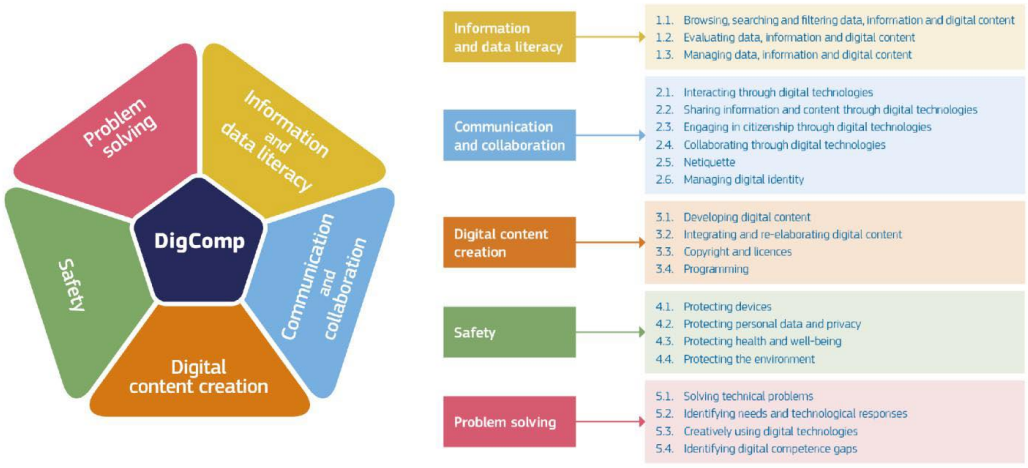

Figure 1: This figure shows the five primary principles of DigComp along with the 21 competencies within each principle. From "DigComp" an article by the Joint Research Centre, 2018.

There are many innovative implications of the DigComp framework, including using it in job descriptions or as a basis for certifications (Wuerfell, 2017). Despite DigComp not being designed by a regular standardizing body, it enjoys full acceptance and endorsement from the European Union and is used in many countries across Europe to develop assessments of digital literacy (Wuerfell, 2017). For example, in Norway, DigComp has been used as an educational tool for social workers and has continued to emerge as a pivotal part of the curriculum to be a social worker. Social workers use this knowledge throughout their career for tasks such as case management, communication, and service delivery (Zhu, 2022). In a digital society, even career paths such as social work involve the five main principles of DigComp.

Countries and Their Digital Literacy Assessments

Researchers have used the basics from the DigComp framework in order to create test instruments for international analysis. For example, a test created for comparison research between Hungary and Slovakia created questions based on programming, word processing, spreadsheet calculations, and other factors. In Slovakia, Informatics has been a part of compulsory education beginning in the second grade since the 2008/2009 school year, and the standards are structured by what one is expecting to be taught before leaving the school. This is why many seventh graders in Slovakia have been at least introduced to the skill of programming (Kiss, 2012). The Slovakian Informatics curriculum proved itself to be more sophisticated than that of Hungary as Slovakian students scored much higher in the programming section than their Hungarian counterparts. The specialized education of their Informatics course and the time that teachers dedicate to learning the skill are the reasons for Slovakia's higher overall scores in this subject field (Kiss, 2012).

Another example in Norway tested similar skills between different income ranges to determine if socioeconomic status was a factor in digital literacy. They tested the same core concepts as Hungary and Slovakia, using a similar method. Both assessments were conducted online using multiple choice questions, text questions, and questions that involve identifying the correct value from a table (Hatlevik et al., 2013). Similar structures can be found all over the world attempting to create a standardized comparison for the digital literacy of students (Siddiq et al., 2016).

Implications for the United States

While countries affiliated with the European Union have continually supported the DigComp framework, the United States has never sought to standardize a test of digital literacy as these principles have not previously existed in compulsory curriculum. A study conducted in 2002 created a test similar to those that have been previously discussed from other countries; however, because of the ever-changing nature of technology, a standardized assessment of digital literacy is a necessity for the improvement of technical infrastructure of schools in the United States (Ba et al., 2002). In 2008, a pioneer study in Maine assessed students using three websites and asking the students to identify the usefulness of the information that they gathered from the given websites (Silvernail et al., 2008).

METHOD

Research Method

Outlining the potential inclusions for an assessment of technology education primarily involves recognizing patterns in the terminology from other assessments worldwide. That being said, the researcher chose qualitative research, specifically unobtrusive data, to complete this project. Unobtrusive data is data that is collected without disrupting the daily life of a human being and comes from previous research on the subject (Hatch, 2023). Using unobtrusive data on the topic, the researcher can demonstrate connections between the pre-existing exams worldwide and create generalizations to be implemented by the state of Tennessee.

To begin gathering unobtrusive data about technology education assessment metrics, the researcher used Google Scholar by searching the words/phrases “digital literacy” and “technology education.” Sources such as Siddiq et al. from 2016 offered alternative synonyms of “digital literacy” to search for, such as “21st-century skills” and “ICT literacy.” The aforementioned source also allowed connections to be made to specific papers regarding assessments from other countries worldwide. Many of the sources referenced the DigComp framework, which offered a different avenue of research for pre-existing standards as well as created a concise list of sections that represent digital literacy skills.

Method of Source Analysis

Before truly analyzing the data, the researcher made the choice to limit the intake of unobtrusive data. The results were narrowed to those after the year 2012 with the hope that this would yield accurate modern representations of technology use in the classroom. A noticeable exception to this rule is Ba et al. from 2002 as this source is primarily used to demonstrate the long-awaited response for an agreed-upon assessment in the United States as it pertains to digital literacy.

DigComp provided an example of standards that many countries followed. That being said, the five main sections of digital competence as defined by DigComp are "information and digital literacy," "communication and collaboration," "digital content creation," "safety," and "problem-solving" (Carretero et al., 2017). Therefore, to analyze and draw conclusions from other countries' assessments, the DigComp framework was used to point out the patterns in various forms of testing worldwide.

Analyzing the data involves asking questions about the data that work together to create connections and eventually answer the research question (Hatch, 2002). Within each of the five sections, the researcher examined the data asking questions about what other studies have done specifically to test a certain competence metric. Having sorted all of the data into these sections, the researcher drew conclusions regarding what is important and applicable to test Tennessee's students on their digital literacy.

RESULTS

After narrowing down the international experiments, there were nine analyses left each from a different nation. Of the nine examples, Principle 1, Information and Data Literacy, was assessed every time. Principle 2, Communication and Collaboration, was included five out of nine times. Principle 3, Content Creation, was included in seven out of nine experiments. Principle 4, Safety, was incorporated into seven out of the nine experiments. Principle 5, Problem Solving, was not utilized directly in any of the assessments.

Breaking down these results further, in six out of nine international experiments, Principle 1, Information and Data Literacy, was assessed through the use of multiple choice questions. Of the five studies that included Principle 2, Communication and Collaboration, in their research, three utilized an interactive format to test efficiency in this category. Principle 3 was similar in that the majority of the studies that included an assessment of Content Creation were conducted in an interactive format. The types of questions associated with Principle 4, Safety, were evenly divided between the studies that included it in the test. Australia and Chile used a free response format while Italy and Norway used multiple choice.

Therefore, the results of this study illustrate that the most common way to assess growth in technology education is utilizing a testing format that combines multiple choice with interaction simulations. From the nine experiments, only four tested all Principles 1-4; three of these four used an assessment that included both formats. That being said, the researcher concludes that in order to test the

efficacy of Public Chapter 979 in Tennessee, a format that includes both simulated interaction and information based multiple choice questions would be ideal.

DISCUSSION

Principle 1: Information and Data Literacy

When looking at the five principles at a glance, information and digital literacy is the most straight-forward in that it is the most focused on facts. The first competency is broken down into two sections. The information section focuses on the recall of specific technical jargon while the data literacy section focuses on the ability to evaluate and use online sources of information (see Figure 1). The most common testing method for knowledge-based or retention skills is a multiple choice format, and this assumption holds true in the majority of the experiments that were observed.

Researchers in different countries took alternative approaches to this competency. For example, in Norway, multiple choice questions were asked in a variety of ways, some being definitional while others involved choosing a reliable source when presented with a list. They were asked vocabulary questions such as "What is a 'cookie'?" as well as questions of legitimacy such as "Can you trust information from this source?" (Hatlevik et al., 2015). A test conducted in Chile gave students a list of keywords to choose from if they were to search for a given subject (Claro et al., 2012). In Australia, students were given a pop-up window and asked different questions about which program would be used to perform an action, or to identify the result of clicking a certain button on the screen (Fraillon et al., 2015). These are just a few of the approaches to the multiple choice assessment of a student's skills in Principle 1.

A study conducted in China took a different approach to the multiple choice format. For this test, which was given to students in Grade 5, students were able to navigate through sources to determine which would be more helpful for a research on a specific topic. They also focused more heavily on the identification of facts and opinions. Another unique trait of this example is that it asked students to identify a narrow topic of research (Chu, 2012). Another example that focused more on using sources efficiently and properly came from a previous study in the United States. In this example, students were asked what sources they would use given a hypothetical assignment (Huggins et al., 2014). Testing these principles is important for all three competencies that fall under this principle (see Figure 1) and is increasingly more important to be successful in adulthood and the workforce.

A study conducted in Hungary used a completely interactive test for Principle 1, which differed drastically from the approach that other countries took for this principle. Their test was a simulation that involved three tasks, which adapted based on the students' responses. Students were either asked to choose the most appropriate decorations for an event that they were planning or to research the cost of tickets to a theme park for the student and their family (Tongori, 2013). Another study in the Netherlands focused on an authentic situation. It provided students with a scenario in which they were planning a trip to France and needed to find a lodging place that satisfies the wants of both them and their parents (Van Duerskn and Van Diepen, 2013).

Principle 2: Communication and Collaboration

Similar to Principle 1, Principle 2 is broken down into two smaller categories. Communication specifically involves using various digital platforms to have professional interactions with others who also occupy similar spaces on the internet; collaboration is a subcategory that outlines the rules of internet etiquette and digital citizenship (see Figure 1). This competency was less represented in the research, but when it was present, it was usually tested in an interactive *format* rather than multiple choice.

A test from Belgium provided students with a simulation in which they were required to use the online platform to send an email (Aesaert et al., 2014). This is the most common way of testing a student's ability to use technology to communicate and share information using programs. It allows the student to have control of their environment and practice using it as they will have to for the foreseeable future.

Once again, a similar result was observed from the study conducted in Chile. Using an interactive simulation, students were asked to write and send an email and draft and ask a question in a forum (Claro et al., 2012). Both of these tasks revolve around mechanically being able to communicate online while also following the rules of digital citizenship and etiquette that are used in collaboration with others.

Overall, though it is less represented in the observed research, communication and collaboration are imperative to the daily use of technology. Having a professional online presence has become increasingly important with the use of platforms such as LinkedIn. Still, there was a noticeable pattern in the

method used to assess whether or not students are able to execute the task at hand. In this case, the most common testing method was one that utilized an interactive simulation. The free response nature of digital communication lends itself to being tested in a similar format, so this method allows students to fully exhibit what they know about the competencies under Principle 2 (see Figure 1) by forcing them into a situation in which they must demonstrate their abilities without being led in a direction by the use of multiple choice questions.

Principle 3: Content Creation

Principle 3 differs from the first two in that it leans heavily on students' creativity. The principle and the four competencies associated with it (see Figure 1) revolve around the ability to create something using technology given a problem or a task to complete. Skills that would fall under this category include programming, PowerPoint making, or website building. Interactive testing allows for complete customization for the students, so they are able to show all that they are capable of doing using the software that they are given.

The study conducted in Belgium presented students with a prompt asking them to search for images of two dinosaurs and insert them into a PowerPoint. The students were given a specific website to search for these images, but other than that, they were able to take creative liberties in what images were picked and how they were placed onto the slide (Aesaert et al., 2014). Being able to acknowledge and complete a task like this one is becoming increasingly important for a great deal of career paths. This method of testing simulates freedom that students will likely have in their futures at the workplace.

Similarly, the test from the United States required students to use a word processor to provide narration for a website (Huggins et al., 2014). In the same vein, Australia presented students with an instruction document and asked that they update a fake website according to the directions that they were given (Fraillon et al., 2015). Though students were asked to perform different tasks, the ultimate goal of testing content creation is still realized through the use of minor direction and guidance to perform a creative task.

Principle 4: Safety

Principle 4 focuses heavily on protection, including protection of devices, privacy, health, and the environment (see Figure 1). In the modern age when the Internet is being used for such a variety of purposes, it is imperative that everyone who utilizes the resource knows how to do so safely. This principle focuses on making sure that technology education is emphasizing the best way to protect oneself digitally. As previously stated, there were two main approaches to the assessment of this principle.

The study in Norway used specific multiple choice questions to test whether or not students understood basic rules of internet privacy. For example, some of the sample questions asked questions about the social media platform Facebook and who owns the images that are posted there. There were also questions regarding viruses and their potential causes (Hatlevik et al., 2012). Italy had a similar test structure (Calvani et al., 2012). The tests given in Norway and Italy were both solely composed of multiple choice questions, so they likely followed similar question formatting techniques covering the same information across all of the principles.

Australia and Chile took a different approach, relying more heavily on free response questions. Australia focused on privacy, similar to Italy and Norway, but students were able to type out a response about privacy as it relates to using internet platforms, such as social media (Fraillon et al., 2015). This approach allows students to fully articulate their feelings about internet safety and fully demonstrate their understanding without being held to the constraints of given choices. The study in Chile also allowed students to respond freely to a prompt, but the subject area was slightly different. The question that they were given to answer combined safety, ethics, and societal impact. It asked students to write an essay about the role that technology and the Internet plays in society (Claro et al., 2012).

Overall, the method of testing of Principle 4 seems to depend heavily on which of the competencies is being tested. Italy and Norway focused on Competencies 4.1 and 4.2, which heavily emphasize the protection of devices and privacy, and both used multiple choice questions for the purpose of testing those competencies. On the other hand, the free response example from Chile broadens to the impact of technology in society rather than individual safety. This method likely serves to test Competencies 4.3 and 4.4, which also broaden to the external world rather than the individual. While not an exact parallel, this pattern makes sense because there is a potential for individualized thoughts when it comes to protecting well-being and the environment, so giving students the opportunity to fully express themselves unconstrained is more conducive to this competency.

Principle 5: Problem Solving

Principle 5 was drastically underrepresented by the pre-existing experiments that were used for this project. That being said, it is unclear which of the testing types would be the most valuable for testing the ability to problem solve. However, problem solving skills tend to be embedded into many testing formats, whether explicitly mentioned as intentional or not. For example, the Hungarian study previously discussed for Principle 1 uses an adaptive testing platform, which requires students to reason through various tasks while adapting to their answers (Tongori, 2013). This creatively includes a reference to Competency 5.2 (see Figure 1).

In addition, a multiple choice format allows students to solve problems that may come up while they are doing research for a specific task. Once again, referencing the study from Australia, students were presented with a pop-up window and asked what button would elicit a certain response to close the window (Fraillon et al., 2015). This example utilizes Competency 5.1 (see Figure 1). The examples of tests for Principle 3 also test whether or not students can use digital technology creatively (Competency 5.3) using an interactive format. Therefore, it seems logical to conclude that in order to test the ability to problem solve, a proper test would give the students an interactive task where they must reason through a situation and solve problems through the experience.

Generalizations for Tennessee

Following the passage of S.B. 2406, which creates the requirement of one year of computer science education for high schoolers, the Tennessee Department of Education sought to refine the standards for technology education in the state.

This was in direct response to the fact that while 48% of students who take the ACT have expressed interest in STEM fields, only 21% actually meet the STEM benchmarks on the ACT (Tennessee Department of Education, 2022). They have developed a framework of the six core concepts of computer science in K-12 education. These concepts include foundational concepts, programming concepts, impacts of computing, networking and the Internet, data and analysis, and algorithmic thinking (Tennessee Department of Education, 2022). Overall, this framework complements the DigComp framework. As a result of the similarities, the studies conducted globally are reliable suggestions of methods of testing digital literacy in Tennessee in the coming years.

While the new requirement emphasizes the importance of technology education in high school, it is still imperative that K-8 students have a base level of knowledge that prepares them for the courses they will encounter in high school. The new standards for elementary school students heavily focus on the foundational concepts and the impacts of computing, which are similar to the DigComp principles of information and safety. As previously discussed in the sections on these two principles, many successful assessments of these principles use multiple choice questions to determine if students understand the material within those principles.

Given the emphasis on foundational concepts in the elementary school standards, a basic multiple choice test with one free response question taken in the fifth grade would accurately assess their factual knowledge of foundational concepts of computer science. The multiple choice test could follow a similar

format to the study from China (Chu, 2012). According to the Tennessee Department of Education standards, fifth grade students should be able to "analyze the effect of social media on individuals, family, and society" (Tennessee Department of Education, 2022). This standard opens the door for a free response question that requires students to articulate their perceptions of social media, similar to the approach taken in Chile (Claro et al., 2012).

Moving forward to the middle school standards, the biggest change is a shift to content creation in the form of projects and programming (Tennessee Department of Education, 2022). Other than that, the changes just reflect the maturity of the students and their capacity to think critically about tasks. Therefore, the need for a specific assessment during these grades would be an unnecessary burden to take on. Instead, middle school should serve as a learning environment to bridge the foundational concepts of elementary school with the specialization of high school.

According to S.B. 2406, during any point in a student's high school career, they can choose to take a computer science course to satisfy this requirement for graduation. Therefore, the standards for high school cannot be grade specific; rather, they are written under the assumption that the student will be able to complete certain tasks by the time they graduate high school (Tennessee Department of Education, 2022). When testing the effect of this required computer science course, it would make the most sense to test the students as they complete the requirement instead of a specific grade. As with the standards, this

assessment would be completely independent of any specialized courses such as AP Computer Science Principles or AP Computer Science A (Tennessee Department of Education, 2022).

At this point in their academic career, there is no longer room for the learning of foundational concepts, which is why it is important that this knowledge is retained from their technology education in elementary and middle school. The greatest number of standards fall into the creative and argument-based sections of networking, the Internet, and the impacts of computing (Tennessee Department of Education, 2022). These core concepts mirror Principles 2-5 of DigComp.

Based on the previously identified patterns, testing of these principles is most commonly done through free response questions and interactive simulations. The standards set by the Tennessee Department of Education emphasize the importance of being able to respond efficiently when presented with a problem. Many of the standards involve debugging programs or errors in an algorithm (Tennessee Department of Education, 2022). These standards aim to measure students' capability to respond to a situation, so in order to be tested well, there must be an interactive element.

The study conducted in Hungary adapted to students' responses in real time, presenting them with different options depending on what they selected (Tongori, 2013). Something similar would likely be beneficial in Tennessee to test capability to respond in real time to problems in a program or algorithm. Another option could be that the students are given a faulty program and asked

how they would go about fixing it. Combining many standards into one interactive exercise is also a potential solution. When Tennessee students graduate high school, there is a wide variety of standards they are expected to meet, expanding all the way from the use of data to create visuals and models to debugging programs that do not run correctly (Tennessee Department of Education, 2022). Imagine students are given a dataset and asked to create a computational model based on it; then, they are presented with the faulty code of a fake student and asked how they would go about correcting the problem. The exercise could go even further and ask the student to make suggestions in a written format that would make potential codes easier to test and debug. All of which are standards crossing three of the six core principles of Tennessee computer science education (Tennessee Department of Education, 2022).

Questions formatted in this way allow students the freedom to creatively and intuitively reach the answer, which reinforces the content creation element of computer science. In addition, oftentimes, there is more than one way to solve a problem, so giving the students the freedom of exploration is practical for their futures in the workforce. Outside of just providing a metric of assessment, a test of this type allows students to think critically about solving a problem, which will once again benefit them in the future and make them stand out in their careers.

A test that covers all of the standards would also include an essay question, similar to the proposed question for fifth graders. This essay question would combine the two core concepts of networking and the Internet and the impacts of computing. By the time that they graduate high school, students are

expected to be able to “evaluate and debate the social and economic implications of computing in the context of safety, law, and ethics” based on the impacts of computing concepts (Tennessee Department of Education, 2022). This goes along with standards from the networking and the Internet standard that students will know and be able to discuss laws relating to technology use and digital identity (Tennessee Department of Education, 2022). Once again this follows a similar precedent set by the experiment from Chile (Claro et al., 2012). Other countries approached these standards in a similar manner, so it would not be uncommon were Tennessee to follow suit in the use of a free response question to test this subject area.

Asking a question that requires students to take a stance on a specific law related to technology use would be a way to test their ability to think critically and articulate an opinion using information that they have learned from their computer science education. They can draw evidence from what they have learned from other standards within the two concepts. Overall, it allows the student to be able to form and articulate an opinion, which is also an important skill to possess for their futures.

CONCLUSION

Study Summary

This study came as a result of a change in Tennessee graduation requirements according to S.B. 2406, which inspired a deep dive into the potential tests that measure the efficacy of this change as it pertains to reaching the overall goal. Using experimental assessments collected internationally, patterns in the assessment of technology education were identified. Through the combination of the DigComp framework and Tennessee state standards, the researcher was able to make generalizations resulting in a hypothetical testing path for technology education specifically.

In summary of the results, using a simple multiple choice test at the end of elementary school demonstrates a clear understanding of the foundational concepts and a readiness to continue further into the study of computer science. Middle school instruction should serve to bridge the foundations of elementary school with the application of high school, no assessment necessary. Then, in high school, the standards emphasize individual creativity and personal ability to respond; therefore, a free response format allows students to demonstrate and apply their knowledge. Taking this approach of developing assessments using multiple formats allows for the testing of specific standards throughout K-12 technology education, which would allow Tennessee to determine the impact of S.B. 2406 and these new standards on closing the gap between STEM career interest and benchmark ACT score.

Limitations

The previous examples from other countries were experimental, so it cannot be determined whether or not they would work in a practical environment, such as a statewide comprehensive assessment. These samples also focused on different grades and came from different cultures, so following the examples directly as they were outlined would likely not translate to the Tennessee situation. Therefore, everything that resulted from this research is a generalization and should be interpreted as such. The proposed format does have merit and could prove beneficial to future research, but as far as the types of questions, adjustments will be needed depending on class structure and age of the students.

Implications for Practice

This study brings new light onto the DigComp framework, which is not normally used in American contexts. Opening this door allows for the use of a common and widely accepted tool for developing technology education standards. This study also introduces the potential for use of other international frameworks for similar purposes to provide an alternative perspective to the assessment of technology education. Overall, this research provides a potential roadmap for test designers and future researchers to use when developing assessments of technology education. These suggestions based on the DigComp framework could prove to be helpful in Tennessee as well as other states.

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