PERCEPTION & APPLICATION OF DIGITAL INTEGRATION IN A CLASSROOM ENVIRONMENT

by

Juliet Lohr Reyes

Submitted in partial fulfillment of the

requirements for Departmental Honors in

the Department of Business Information Systems

Texas Christian University

Fort Worth, Texas

May 6, 2024

PERCEPTION & APPLICATION OF DIGITAL INTEGRATION

IN A CLASSROOM ENVIRONMENT

Project Approved:

Supervising Professor: Patricia Jordan, Ph.D.

Department of Information Systems and Supply Chain Management

Richard Alexander, Ph.D.

Department of Education

ABSTRACT

This comparative study examines the TPACK framework, initially proposed by creators Mishra and Koehler (2006). The framework assesses how teachers integrate technology, pedagogy, and content knowledge in their respective subject-focused classrooms. Within the classroom environment in an elementary school, the study focuses on perspectives from two groups: The subject teachers and their students in the 5th and 6th grades. The research expands on the importance of Digital Literacy, the difference between traditional vs digital literacy, and the misconception of disadvantages in the Digital Gap. It explores two different viewpoints: why teachers struggle in incorporating digital integration in the educational environment and in contrast, how districts and schools have incorporated TPACK into their environment. The comparative study included quantitative surveys distributed to both groups of teachers and students for data analysis, comparing the variances, means, and P-value within groups. By evaluating the effectiveness of these three disciplines, the study measures the teacher's self-assessment and the students' perceptions of their teachers.

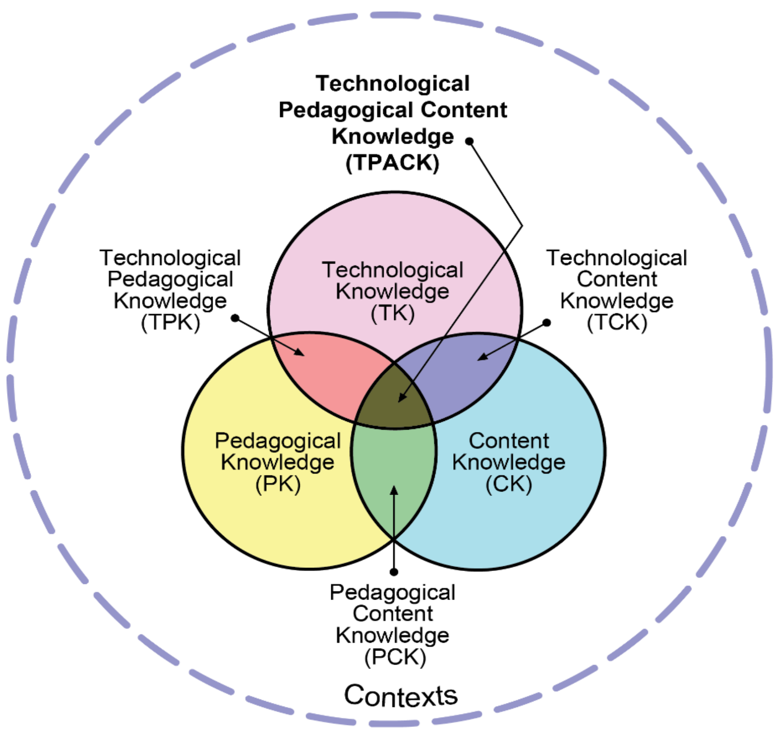
INTRODUCTION

How do educators go beyond simply providing information when teaching digital literacy? How do they ensure that students acquire the necessary skills for today's classroom, including effective use of digital tools, heightened engagement, and hands-on experience? This comparative study seeks to explore the realms of application and perception regarding digital integration within a classroom environment. The central research revolves around the TPACK (Technological, Pedagogical, Content Knowledge) framework proposed by Mishra and Koehler in 2006. Specifically, this study explores how teachers' utilization of technology integration correlates with students' comprehension of technology integration, teaching methodologies, and content knowledge. The primary goal of this paper is to understand whether a teacher's implementation of technology integration leads to practical knowledge in digital tools, or if it is merely a transmission of information without fostering an understanding of the digital tools' versatility and applications.

TPACK COMPONENTS

According to Dr. Curby Alexander, an Associate Professor of Professional Practice in the TCU College of Education, while learning methodologies have changed from generation to generation, how the brain functions has not changed. Dr. Alexander, an expert in Teaching & Technology in Higher Education, has contributed to publications in journals such as the *Journal of Technology and Teacher Education* (2020). He emphasizes that individuals continue to learn in the same manner, but what has evolved are the students' strategies for learning. Technology gives the appearance that people can learn faster or easier (i.e. why read textbooks when there is visual media). Technology can provide more avenues for learning, but it can become harmful when individuals refrain from critical thinking and resort to copying and pasting provided information (2023). The COVID-19 crisis has emphasized the importance of technology-mediated learning, making it more relevant now than ever (Mishra, 2020). The Technological Pedagogical Content Knowledge (TPACK) framework shown below stands out as one of the most recognized frameworks for comprehending the knowledge teachers require to integrate digital technologies into teaching practices (Koehler & Mishra, 2008).

The TPACK Framework from tpack.org



The TPACK framework is a Venn diagram that simplifies the intricate relationships of three types of knowledge in a classroom environment: Technology Knowledge (TK), Content Knowledge (CK), and Pedagogical Knowledge (PK). This is a theoretical construct that describes the knowledge that teachers use to intelligently integrate technology into their practices (Harris & Hofer, 2017). The deliberate blend of these components provides teachers with a framework of what they want to teach, how they do it, and the tools that best allow them to convey this, bringing the emergence of TPACK (Mishra, 2020).

CK (Content Knowledge): refers to teachers' expertise in the subject matter they teach. It includes knowledge of concepts, theories, evidence, organizational frameworks, and established practices within a specific discipline (Shulman, 1986).

PK (Pedagogical Knowledge): encompasses teachers' understanding of instructional methods and practices. It involves knowing how to manage a classroom effectively, plan lessons, and assess student progress (Mishra & Koehler, 2006).

TK (Technological Knowledge): pertains to teachers' knowledge of specific technologies and their applications in instruction. This includes familiarity with tools in learning management systems (LMS), multimedia platforms, interactive whiteboards, the internet, digital video, and other advanced technologies (Niess et al., 2009).

Technological knowledge cannot be isolated from pedagogical and content knowledge; this framework is conceptualized as teacher knowledge, with TPACK at its core, representing the essence of effective teaching (Mishra & Koehler, 2006). In a livestream panel by Monash Education, one of the TPACK founders, Punya Mishra, emphasized that despite TPACK originating years ago, it remains highly relevant to contemporary teaching practices (Mishra, 2020). The broader dotted line surrounding the diagram signifies that this framework is an abstraction of the classroom environment; local context plays a significant role in how technology integration occurs (2020).

In a scenario Mishra provided (2020), when considering context, the approach of a high school mathematics teacher differs from that of a university literature teacher. The tools and technologies vary accordingly. Mathematics instruction may involve simulations, visualizations, or tools for equation mapping. Conversely, a literature classroom may focus on peer review platforms like blogs or other online platforms (2020). Regardless of the subject, technology tools must align with the content and pedagogical approach of the classroom. Teachers must carefully assess how these tools interact with each other and, more importantly, how the local context facilitates their integration (Mishra, 2020).

The TPACK framework serves as a conceptualization that outlines technology, pedagogy, and content knowledge from an analytical standpoint. This not only aids researchers in quantifying and assessing the framework but also prompts practitioners to evaluate whether they have selected the appropriate technology for their content and pedagogical approach. The core idea behind TPACK remains essential and powerful — effective teachers inherently comprehend the significance of this integration. TPACK serves as a structured framework that encourages teachers to consider the types of knowledge, leading to more thoughtful and effective instructional practices (Mishra, 2020).

LITERATURE REVIEW

As technology becomes more integrated into our daily lives, it continuously evolves, setting a critical need of digital literacy skills for individuals to excel in different endeavors. Individuals lacking digital literacy skills face a significant disadvantage in this landscape, contributing to the digital learning gap (Cator, 2022). The digital learning gap is the difference in how individuals, in and out of school, access and use technology to improve learning opportunity versus those who do not.

Approximately over a third of individuals in the Unites States without a high school diploma refrain from utilizing the internet (Cator, 2022). Rural residents are over twice as prone to refrain from internet usage compared to those in urban and suburban areas (Cator, 2022). Those who opt out of digital literacy face challenges in terms of employment, federal assistance, healthcare through public health insurance exchanges, and educational resources (Cator, 2022).

When addressing the digital divide, the focus isn't solely about individuals having access to technology; rather it shifts to their active participation in digital literacy. One strategy of overcoming this gap is to improve the use of technology in classrooms and teaching students to be comfortable with digital tools. This approach can reduce digital illiteracy. Teachers who adopt the TPACK framework play a large role in bridging this digital divide.

Significance of Digital Literacy

Digital Literacy is crucial for seizing opportunities and escaping the cycle of poverty, but not in the way that people think. When it comes to education, students who do not heavily rely on technology to learn don't face a disadvantage. There is a need for classical education, class discussion, thinking deeply about texts, writing skills and written expression. However, the disadvantage in society arises from a lack of understanding regarding how digital literacy can empower a person to rise out of poverty. Cultivating an idea, pursuing entrepreneurship, and launching a business are all feasible paths, yet they pose considerable challenges without adequate use of technology in today's society. Demonstrating the benefits of digital literacy is crucial, and education has been proven as the most promising avenue towards upward mobility (Alexander, 2023).

What does it take to pursue an education out of poverty? Many educational options require the use of technology, such as processing college applications, completing FAFSA forms, and exploring college degrees — all require familiarity with technology. For instance, the proper use of a search engine and how to isolate information that is relevant and irrelevant are essential skills. When individuals lack a high degree of digital literacy, they cannot leverage the benefits of technology. Benefits that can extend to job applications, marketing businesses, managing credit cards, and more. (Alexander, 2023).

Traditional vs Digital Literacy

Understanding the significance of digital literacy allows individuals to bridge the gap between contemplation of digital literacy to effectively leveraging the benefits of technology. Furthermore, digital literacy can be explored more in depth through the distinctions between traditional and digital literacy (Ribble, 2011).

Traditional literacy is the foundational ability to read and write, enabling individuals to interpret, analyze, and communicate in the written language to engage in critical thinking (Ribble, 2011). On the other hand, digital literacy is an extension of traditional literacy as it encompasses the skills needed to communicate, evaluate, locate and create digital information. When distinguishing between traditional and digital literacy, there are several key differences to consider: Medium, Required Skills, and Communication Methods (Saijal, 2023).

Medium: Traditional literacy entails printed media such as books, worksheets, or printed articles. On the other hand, digital literacy encompasses various digital formats like websites, e-books, online articles, blogs, and video-sharing platforms (Saijal, 2023).

Required Skills: Traditional literacy emphasizes reading, writing, communication, and critical thinking skills. In expansion, digital literacy requires proficiency in a range of digital skills such as using devices (e.g., computers), navigating online platforms (e.g., social networks or informative websites), utilizing digital communication tools (e.g., Slack or Teams), engaging in online collaboration (e.g., shared documentation or video conferencing), demonstrating creativity (e.g., digital content or multimedia presentations), applying critical thinking (e.g., evaluating online information or solving digital problems), and possessing practical and fundamental skills (e.g., online safety practices) (Saijal, 2023).

Communication: Traditional literacy often involves face-to-face or written communication, such as conversations, debate, leadership positions or written assignments and exams. In contrast, digital literacy extends communication methods to include digital means, such as email, instant messaging, video conferencing, social media platforms (e.g., Gmail or Zoom), and collaborative online spaces (e.g., discussion forums) (Saijal, 2023).

Digital Literacy in Education

The TPACK framework aligns with the need for digital literacy in education by encouraging educators to seek out innovative ways in understanding how teaching and learning can be transformed when specific technologies are utilized in specific ways (Mishra & Koehler, 2006). It involves recognizing the affordances and constraints of various technological tools in relation to the classroom subject and developing appropriate instructional strategies (Mishra & Koehler, 2006).

For example, a teacher may employ a learning management system for the lessons plans (TK) while possessing a solid knowledge of the content (CK). However, if the students' progress through the entire course without engaging in class discussions or interactions, it creates a gap in the methodology (PK) (PowerSchool, 2022).

This example highlights that the technological knowledge (TK) and content knowledge (CK) are met, but the learning experience (PK) for students is not enhanced. The framework emphasizes the desire for a middle ground which interacts with all three core components. It is the intricate relationships among these three components which determine the extent and quality of educational technology integration but can vary significantly across subject-focused classroom setting (Mishra & Koehler, 2006).

TPACK becomes particularly significant because many widely used software programs and web-based technologies are not designed explicitly for educational purposes (Mishra & Koehler, 2009). For instance, software programs like Microsoft Office Suite are primarily created for business environments, while web-based technologies such as blogs or podcasts are designed for entertainment and communication (Mishra & Koehler, 2009).

To effectively integrate these technologies into education, teachers must move beyond their conventional uses and adapt them creatively for customized pedagogical purposes (Mishra & Koehler, 2009). With a better understanding of the importance of TPACK framework and its significance, a practical application with the classroom context can be applied with an example provided below from a video by Sophia.org (PowerSchool, 2024).

Original Lesson Plan

Consider the scenario of being a 7th grade life science teacher, focusing on the topic of "cell anatomy." The learning objectives entail describing animal cell anatomy and explaining how organelle function collectively to execute essential cellular processes (PowerSchool, 2024). Typically, the lesson might unfold as follows:

1. Present a detailed explanation of cell anatomy and the fundamental roles of each organelle, utilizing textbook diagrams (printed or digital).
2. Divide students into small groups. Task each group with labeling their own cell anatomy diagram and researching a specific cellular process.
3. Have each group present to the rest of the class the cell process they researched.

Now, let's explore how the TPACK framework can leverage this knowledge of these domains withing the context of the classroom instruction (PowerSchool, 2024).

Content Knowledge (CK): The teacher's first step is to assess their own comprehension of the subject matter being taught; a solid understanding of cellular anatomy and functions.

Pedagogical Knowledge (PK): The teacher should consider how students learn best and identify instructional strategies that align with their needs and the lesson objectives.

Technological Knowledge (TK): The teacher needs to evaluate the digital tools available and determine which ones are suitable for enhancing the lesson. For example, utilizing tools for creating answer keys, sourcing images online, or developing interactive slides.

Integrating TPACK into Lesson Plan

By weaving these elements of TPACK, educators can enrich their lesson activities from the original lesson plan to allow educators to evaluate themselves more strategically in how they incorporate technology in the classroom setting (PowerSchool, 2024).

1. **Check for Understanding Quiz:** After teaching the various aspects of cell anatomy, the teacher can divide students into small groups and engage them in a collaborative check for understanding quiz using the Learning Management system (LMS). Interactive questions can include diagrams of a cell with black labels where students can drag and drop the correct labels from the answer key (PowerSchool, 2024).
2. **Comparative Cell Process Analysis:** Assign students to create an artifact to draw differences and conclusions between animal and plant cells. This can be a flowchart comparison or a video explanation to be submitted via the LMS for assessment (PowerSchool, 2024).
3. **Digital Posters**: students can use digital tools to create engaging and informative posters personifying cell organelles to enhance engagement and digital literacy. The digital platforms can include Canva, Adobe Spark, or Google Drawings to design the poster (PowerSchool, 2024).

TPACK at its core does not equate to separating proficiency to its three primary components (TK, PK, CK) but rather a relationship to utilize technology strategically. There is no universal method for integrating technology into the curriculum; instead, integration efforts should be thoughtfully designed for specific subject matter and tailored to individual classroom situations (Eshet-Alkalai & Amichai-Hamburger, 2004).

Factors Affecting Teachers' Integration of Technology

Currently teachers are expected to possess the ability to integrate the knowledge of content, pedagogy, and technology known as TPACK (Harris & Hofer, 2011). They are expected to be skilled educators who effectively teach, have mastery over the subject matter, and utilize technology in their instruction. However, many teachers lack experience and preparation in using digital technologies for teaching and learning (Ertmer, 2005). The rapid development of educational technology in recent years has left some teachers feeling ill-prepared and uncertain about its value and relevance in the classroom (Ertmer, 2005). Acquiring new knowledge and skills related to technology integration can be challenging, especially when it requires significant time investment within busy schedules. Additionally, teachers may struggle to envision technology uses that align with their existing pedagogical beliefs (Ertmer, 2005). Inadequate training further compounds these challenges, as many professional development programs offer a standardized approach to technology integration without considering the diverse contexts in which teachers operate (Ertmer, 2005).

Dr. Alexander states that in theory, a teacher preparation program (or workshop) should incorporate the utilization of technology as a teaching tool set within the classroom. The challenge arises with veteran teachers whose training may be outdated, hindering their ability to adapt to technological advancements (2023).

Technology normally gets adopted when educators learn new technology and how to integrate it into their classroom practices to align their lectures in a new way. For many educators, the COVID-19 pandemic forced teachers to rapidly adopt technologies to teach students online. Mandatory workshops and online courses arose primarily because of the COVID-19 pandemic.

For example, Texas Christian University mandated that educators had to take required training on *'how to manage class remotely or hybrid setting'* during the initial stages of the pandemic (Alexander, 2023). But, once in the classrooms, some teachers reverted to a traditional teaching method.

There is no state-level requirement mandating that teachers stay updated with technological advancements. Managing technology integration at a state-level with educators is unfeasible and impractical in terms of tracking compliance. According to the 10th Amendment, governmental jurisdiction doesn’t have the authority to impose mandates over state school systems. These initiatives are typically directed from a district or school level, leaving the obligation of enforcement to the principals or vice principals to mandate (2023).

Dr. Alexander expands on this, stating that educators typically get hired by a school that utilizes a broader use of technologies (i.e. productivity tools) but they don’t know how to use to get hired. The lack of competencies in technological skills are normally not considered in the hiring process. Consequently, the lack of these competencies could deprive students of meaningful learning opportunities. In retrospect, digital literacy can support pedagogies that enhance the learning experience. A teacher who doesn’t know how to use technology meaningfully is at a disadvantage leading student at a severe disadvantage in a learning institution (2023). Given the complexity of teaching with technology, educators have developed new ways of understanding and accommodating this intricacy to successfully integrate technology into their instructional practices (Eshet-Alkalai & Amichai-Hamburger, 2004).

Exploring Changes in Teaching Style

Enhancing teachers' TPACK approach involves strategies that can be categorized into three intervention methods: method, tool, and technical interventions (Harris & Hofer, 2011; Schmid et al., 2020).

Method interventions: such as learning by design, collaborative learning, problem-based teaching, case study, and game learning, are widely used approaches (Harris & Hofer, 2011; Schmid et al., 2020). These interventions aim to enhance teachers' TPACK through specific instructional methods and approaches.

Tool interventions: involve the use of various multimedia tools like graphics, audio, video, 2D/3D animation, micro-lectures, presentation tools (i.e., spreadsheets), and Web2.0 tools (i.e., WebQuest) (Harris & Hofer, 2011; Schmid et al., 2020). These tools provide teachers with resources to integrate technology effectively into their pedagogical practices.

Technical interventions: encompass AI-based systems, data collection, analysis software, and interactive whiteboards (Harris & Hofer, 2011; Schmid et al., 2020). These technical interventions offer additional support and resources to teachers in leveraging technology and data for instructional purposes.

Educators' knowledge plays a crucial role in developing the TPACK and there are diverse approaches to support teachers in this process for the context of the subject classroom (Ribble, 2011). However, the educator must have the time, resources, and desire to aquire the skills needed to teach effectively with technology.

How TPACK is used in Schools and Districts

The utilization of TPACK in schools and districts has been a topic of interest, as noted by Judith B. Harris, research expert on technology and education during the Monash Education panel (2020). TPACK, defined as teacher knowledge, has primarily been explored by university-based researchers. Over the past decade, more schools and districts have voluntarily adopted TPACK mainly through graduate courses attended by teacher administrators (2020). Professor Harris sought to understand how these educational leaders discovered, utilized, and interpreted TPACK within their specific context. In collaboration with various schools and districts in the US and Canada, it was found that these institutions either appropriated or reconceptualized TPACK (2020).

In appropriated instances, TPACK was used to connect professional learning initiatives with teachers' learning needs to help teachers understand the different learning opportunities (Harris, 2020). It served as a balancer for educators to ensure that technology integration focused on enhancing curriculum content rather than merely promoting technology (Harris, 2020).

In reconceptualized instances, many institutions viewed that theoretical TPACK had little use and that the TPACK framework needed to be applied knowledge. In other cases, TPACK was recognized as collaborative distribution of knowledge, not limited to just the individual teachers. Different groups of teachers were stronger in technological knowledge, or in curriculum-based knowledge or in pedagogical knowledge. But collectively, they enacted TPACK in their teaching practices (Harris, 2020).

In summary, authors Koehler & Mishra (2008) emphasize the intention of the flexibility in the TPACK framework, while noting its limitations. The framework was never intended revolutionize a broader systemic change in education, but to assist leaders in meeting existing expectations already placed on educators (Harris, 2020). In each of these ways, TPACK has changed in how they have been implemented in each institution (Harris, 2020). It aligns with the importance of digital literacy in education by promoting the purposeful and creative use of technology to enhance student learning and prepare them for the digital world.

HYPOTHESIS

This research focuses on students and educators in primary school, specifically the 5th and 6th grade, to compare and analyze their assessment of their teachers in the local learning environment within the TPACK framework. Researchers are increasingly delving into TPACK's adaptability across diverse contexts, aiming to grasp its complexity in classroom dynamics and compare educator's perspectives within this framework (Philips, 2020). To understand the complex reality of educators, an assessment with TPACK is used to compare the survey results of teachers and students in this framework.

Technology Knowledge vs Technology Frequency

Research by Harris (2020) emphasizes that TPACK changes over time and varies by the researchers' interpretations. In her preliminary research, Harris (2020) introduced the concept of TPACK descendants, indicating the result of different implementations of the framework in research studies. Each descendant is specific to different technologies such as Web based tools (Tech-specific), Design-based learning (pedagogy-specific), and science-applied classrooms (content-specific). Harris identified numerous TPACK descendants, suggesting a wide range of perspectives within the framework to account for different forms of technology in a learning environment. (Harris, 2020). The diversity in TPACK descendants demonstrates a need for investigation between teacher TPACK competency and the frequency in which technology tools are used in the classroom. More frequent use of various tools improves the students overall comfort level and proficiency of digital tools. This will improve the individuals' digital literacy.

Hypothesis 1a: *There is a positive relationship between students' frequency use of technology tools and students' perceived importance of tools outside the classroom.*

Hypothesis 1b: *There is a positive relationship between teacher level of Technology Knowledge (TK) and student frequency of utilizing technology tools outside the class classroom.*

Student TPACK Perspectives

Punya Mishra stated that any representation of knowledge is inherently an abstraction of a complex reality; if the framework completely mirrors the real world, it offers little utility to instructors (Mishra, 2020). The various interpretations of TPACK listed by Judith Harris indicate ongoing efforts by researchers to address the perceived oversimplification of TPACK and its limited capture of every local instructional context. The complexities of TPACK implementation in local educational context demonstrates a need for investigation into how classrooms incorporating TPACK influence students' perspective across core components. While the use of the TPACK framework by teachers will allow for the incorporation of technology into the content and pedagogy, this effort needs to translate into student outcomes and perspectives of TPACK.

Hypothesis 2a*: There is no significant variance between the students' responses in each subject classroom in the TPACK framework (TK, CK, PK).*

Hypothesis 2b: There is a positive relationship between the utilization of TPACK Framework (TK, CK, PK) in the classroom and the student's learning experience.

METHODOLOGY

The research methodology aims to investigate the impact of teachers' technology utilization on students' comprehension and learning experience within the TPACK framework. This encompasses Technology Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK). This systematic comparative study intends to determine if educators' integration efforts cover all three components or if they primarily focus on one or two. In duality, this study will also analyze students' perception addresses all three components or focus on one or two. Additionally, it seeks to explore the correlation between teacher's TPACK utilization and students' digital literacy.

The methodology comprises of two quantitative survey studies conducted at an elementary school. The first group involves four teachers, with data analysis to determine the degree of utilization in the TPACK framework, regardless of the subject they teach, the technology they use, or their preferred teaching style. The second group includes 17 students from 5th and 6th grades, surveyed to gather their perspectives on their respective teachers. These results will provide insights to validate hypothesis 1 and 2.

SURVEY RESEARCH CONTEXT

Author Koehler (2012) noted that TPACK assessment is primarily conducted through surveys, with the most utilized methodology being the "Survey of Pre-service Teachers for Teaching with Technology" (Schmidt, et al., 2009). Although this survey is specifically designed for preservice educators, the survey will still be applicable to licensed educators in K5-6. The survey has been altered to reflect the current licensed teachers. The survey comprises of 12 items gathering demographic data and 52 items focusing on the teacher's self-assessed levels of knowledge in each of the TPACK domains (CK, TK, PK, TCK, TPK, and TPACK). This is a one-time survey educators would need to take on their own to alleviate any biases from peers with an estimated time of 15 minutes to complete. The objectives of this survey are to analyze (1) the faculty's comfort levels and proficiency with technology, (2) the faculty's' frequency use in learning technology tools for instruction, (3) and the faculty's self-assessment in each TPACK domain.

While the first survey specifically focuses on teachers' perception as Group One, another survey was needed to assess students' perception as Group Two. Author John R. Savery explores in his research paper, "Faculty and Student Perceptions of Technology Integration in Teaching," to discover the perspectives of course technology and how it impacts behaviors. This study will utilize their research survey assessment, "Student Technology Integration Survey," by focusing on the student participants. This quantitative survey has been altered to reflect the current technology tools and age-comprehension language for students in K5-6. The survey comprises of 5 items for demographic questions, 11 items in self-assessment in frequency of technology and 6 items in the three domains of TPACK (TK, CK, PK). This is a repeated survey that students need to take for each respective teacher, with an estimated time of 5 minutes to complete. This survey's objectives are to analyze (1) the students' perceptions of technology's impact on their learning. (2) The frequency of use in these technology tools (3) and ultimately the differences between faculty and student perceptions of technology use in the classroom setting.

GROUP ONE: TEACHER PARTICIPANTS

The first group of participants included four licensed educators, all female, and each teaching different subject-areas in grades K5-6. Group one will be addressed as Teacher A, B, C, D and is shown in table 1. Teacher A has 11-20 years of teaching experience and currently teaches Science, Social Studies, and Writing (SSS). Teacher B has 5-10 years of teaching experience and currently teaches English Language Arts and Reading (ELAR). Teacher C has more than 20+ years of teaching experience and currently teaches Visual Arts. Teacher D also has more than 20+ years of teaching experience and currently teaches Mathematics.

Table 1: Teacher Demographics

	Age Range	**Subject Area**	**Years in Teaching**
Teacher A	30 – 40 yrs	SSS	11-20 years
Teacher B	41 -50 yrs	ELAR	5-10 years
Teacher C	51 – 60 yrs	Visual Arts	20+ years
Teacher D	61+ yrs	Mathematics	20+ years

First Learning Methods for Technology Tools

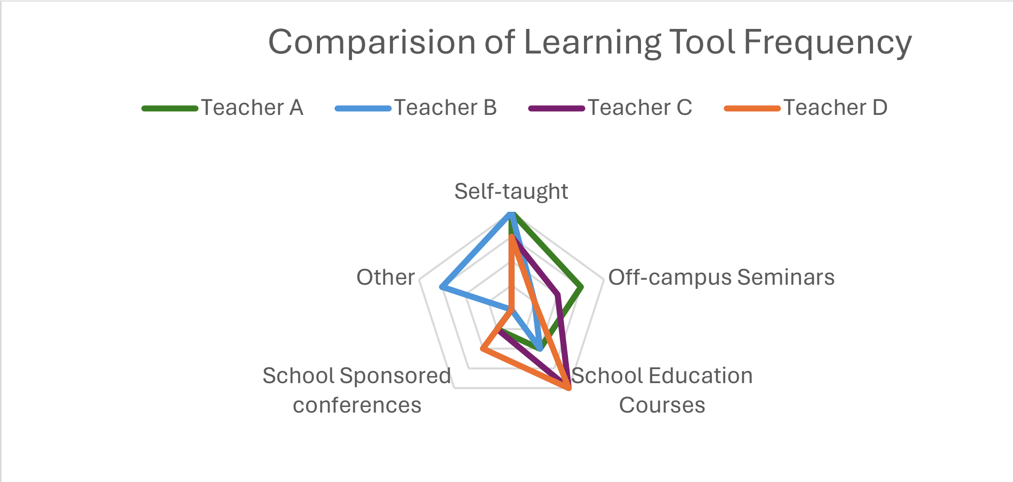
As part of assessing their competency with technology, teachers were asked to state the methods used to learn. This was addressed as one of the demographics questions – "Where did you learn the technology applied in your classroom setting?" Since learning is multilayered, the four educator participants had the option to select more than one tool in their learning experience. The results are shown in Table 2.

Table 2: First Learning Methods for Technology Tool

Learning Method	Count	Percentage
Self-Taught	**3**	**33%**
School Sponsored Conferences	**2**	**22%**
Other	**2**	**22%**
School Education Course	**1**	**11%**
Off-campus Seminars	**1**	**11%**

Table 2 sequentially lists the learning methods by descending order of usage. By summing the total count, each respective learning tool percentage was calculated by the individual count divided by the total count. This emphasizes which first learning method had the most importance in the classroom setting for the educators. When looking at the learning method applied in their instruction classroom, the majority (33%) responded with self-taught. The second most used tool was tied between School Education Course (22%) and Other (22%). The least selected learning style for technology learning was School Education Course (11%) and Off-campus seminars (11%).

Figure 3: Frequency of Prioritized Learning Styles in Technology



The teachers were also asked their preferred learning method – "prioritize the learning styles of the technology utilized in your classroom according to frequency of use. Rank them from most to least frequent." Table 3 displays a radar chart for a visual representation in comparing preferences of the use of different learning tools across multiple teachers. The axis represents the five learning tools and the length of the line connecting the data represents the teacher's frequency of use for that tool. This radar chart indicates that the tools Self-taught and School Education Courses are the highly favored among teachers. The numerical chart for the radar is shown below in table 3.1.

Table 3.1: Frequency of Prioritized Learning Styles in Technology

Learning Style	**Frequency in Preference of Learning**
Self-Taught	**90%**
School Education Course	**80%**
Off-campus Seminars	**55%**
School Sponsored Conferences	**40%**

Other	**35%**

A teacher's first learning method for the technology tool applied in their respective instruction classroom can look different to the frequency of their preferred methodology for continued knowledge. A matrix ranking chart was utilized to look at the multiple items against each other based on a certain criterion. In this case, it was used to compare different learning methodology tools to the four teachers (Teacher A, Teacher B, Teacher C, Teacher D) on a ranking system from a scale of 1 -5. The percentage of preference in learning frequency was calculated based on the matrix ranking shown in table 3.2.

Table 3.2: Frequency of Prioritized Learning Styles in Technology

Learning Style	Teacher A	Teacher B	Teacher C	Teacher D	Total	Percentage
Self-Taught	5	5	4	4	**18**	**90%**
School Education Course	3	3	5	5	**16**	**80%**
Off-campus Seminars	4	2	3	2	**11**	**55%**
School Sponsored Conferences	2	1	2	3	**8**	**40%**
Other	1	4	1	1	**7**	**35%**

The numbers shown above have been reversed so that a ranking of 5 corresponds to the highest preference and ranking of 1 corresponds to the lowest ranking preference. Reversing the ranking indicates that the higher total and higher percentage directly corresponds to a stronger preference or importance. By taking each individual total and dividing it by the number of 20 possibilities (4 teachers x 5 rankings), the total percentage is calculated for each respective learning style.

Figure 4: Educators Adapting to Technology Advancements

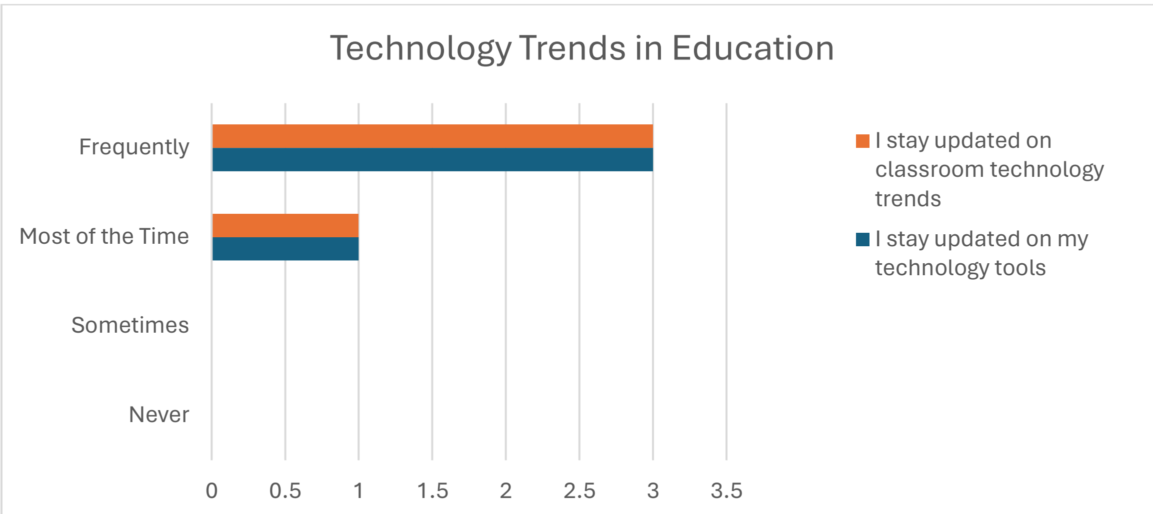


Table 4 reflects how educators adapt to technological advancements for classroom practices. Table 4 shows that three (75%) of educators selected that they continuously stay updated on their knowledge for their subject instruction technology tools and on technology trends in the classroom. Only one (25%) of the educators selected that they are updates on technology consistency and advancements most of the time.

TEACHER DEMOGRAPHIC CONCLUSION

In conclusion, the assessment of teacher demographics regarding their competency with technology provided insights for learning method references. The majority of educators reported being self-taught as their primary learning method for technology applied in their classroom settings, indicating a dependence on self-directed learning. School education courses and other sources also played a significance in frequency of their use for different learning tools, as indicated by the radar chart. Additionally, the matrix ranking chart provided a nuanced view in ranking by strength of preference in percentage. These findings reflect the diverse approaches of educators acquiring and frequency in integrating technology into their teaching practices.

TPACK SURVEY RESULTS

The Technological, Pedagogical, Content Knowledge (TPACK) framework was introduced by Mishra and Koehler in 2006 to assess the knowledge teachers need for technology integration in education. However, a tool was needed to measure this framework. This study utilizes a survey from the "Assessment Instrument for Preservice Teacher," adapted from the Journal of Research on Technology in education (2009) to assess teachers' perceptions of technology integration. The survey of the "Assessment Instrument for Preservice Teachers" involved two main statistical techniques to assess reliability and validity of the survey questions.

1. **Cronbach's Alpha Statistics:** This measures if the questions under each one of the seven domains of TPACK had consistent reliability, specifically how well the survey questions within each domain were reliable under a scale. The Cronbach's alpha

coefficients ranged between .75 to .92 across the seven TPACK domains, demonstrating that this survey is an excellent starting point to ensure data quality and integrity.

2. **Factor Analysis**: this includes factor loading for each domain, used to identify the underlying factors or dimensions within the data. The discussion in the research of "Assessment Instrument for Preservice Teachers" concludes that this educator self-assessment survey is a reliable measure of TPACK within its seven domains for future studies.

This survey has been altered for licensed teachers to self-assess in the seven TPACK domains: For these 52 questions, the teacher participants answered each question using the following five-level Likert scale. The responses from the survey are converted into a "zero centered" Likert scale from -2 to +2 where the midpoint (zero) represents a neutral response. This scale captures the nuance responses from a negative to positive sentiment. The self-rating categories were scored as (-2) Strongly Disagree, (-1) Somewhat Disagree, (0) Neither Agree nor Disagree, (1) Somewhat Agree, (2) Strongly Agree.

STATISTICAL ANALYSIS: DESCRIPTIVE

The results of the self-assessment survey from group one teacher participants and group two student participants, are purely descriptive and only apply to this institution since the sample size is too small to be generalizable to the larger population of students and instructors. An ANOVA test is used for data analysis for its functionality to compare multiple means across multiple groups to evaluate if there are significant differences in the means of dummy variables (response) among the participants. The assumptions of the ANOVA test are met (independence, normality, homogeneity).

- **Independence:** it can be assumed that each row representing the unique respondent is not influenced by other respondent answers.
- **Normality**: it can be indicated for normality with descriptive statistics by seeing the Mean and Median being relatively close and a skewedness close to zero.
- **Homogeneity**: it can be assumed this criterion is met with the F test statistics not exceeding the threshold of f critical and a nonsignificant result of variances ($p>0.05$).

The data was summarized in the seven dimensions (TK, CK, PK, TCK, PCK, TPK, TPACK) and shows the Descriptive Statistics and ANOVA survey results from the four teacher participants.

Technology Knowledge (TK)

This describes teachers' knowledge of, and ability to use, various technologies, technological tools, and associated resources. TK concerns understanding its possibilities for a specific subject area or classroom, learning to recognize when it will assist or impede learning, and continually learning and adapting to new technology offering (Mkoehler, 2017).

Table 5: Technology Knowledge

	Min, Max	Mean	SD
Q1. I know how to solve my own technical problems.	1, 2	1.8	0.5
Q2. I can learn technology easily.	2, 2	2.0	0
Q3. I keep up with important new technologies.	2, 2	2.0	0
Q4. I frequently play around with the technology.	2, 2	2.0	0
Q5. I know about a lot of different technologies.	1, 2	1.5	0.6
Q6. I have the technical skills I need to use technology.	1, 2	1.8	0.5

In table 5 the designated response scale for the survey questions ranged from -2 to +2, but the actual responses only ranged between 1 to 2. The calculated overall mean score was 1.82, indicating a positive consensus regarding the statements in the survey.

The ANOVA test yielded an F-statistical value is 1.2 and the F-Critical Threshold was 2.7, corresponding with a P-value of 0.349. The F-statistic value is lower than the critical threshold and the P-value is higher than the accepted significance of 0.05. These results suggest that there is no significant difference in the Technology Knowledge levels among the four teachers across the different subject areas.

Content Knowledge (CK)

This describes teachers' own knowledge within a particular subject matter. Content Knowledge will differ according to discipline and grade level, or it will differ by the content knowledge that each class imparts to its students (Mkoehler, 2017).

Table 6: Content Knowledge

	Min, Max	Mean	SD
Mathematics Q7. I have sufficient knowledge about mathematics.	1,2	1.5	0.6
Q8. I can use a mathematical way of thinking	1,2	1.8	0.5
Q9. I have various ways and strategies of developing my understanding of mathematics	1,2	1.5	0.6
Social Studies Q10. I have sufficient knowledge about social studies	0,2	1.3	1.0
Q11. I can use a historical way of thinking.	1,2	1.5	0.6
Q12. I have various ways and strategies of developing my understanding of social studies	0,2	1.3	1.0
Science Q13. I have sufficient knowledge about science.	1, 2	1.5	0.6
Q14. I can use a scientific way of thinking.	1,2	1.5	0.6

Q15. I have various ways and strategies of developing my understanding of science.	0, 2	1.3	1.0
Literacy Q16. I have sufficient knowledge about literacy.	0,2	1.5	1.0
Q17. I can use a literary way of thinking.	0, 2	1.5	1.0
Q18. I have various ways and strategies of developing my understanding of literacy.	1, 2	1.8	0.5
Visual Art Q19. I have sufficient knowledge about visual art.	1, 2	1.5	0.6
Q20. I can use a artistic way of thinking.	1, 2	1.8	0.5
Q21. I have various ways and strategies of developing my understanding of visual art.	1, 2	1.5	0.6

Table 6 has an overall mean score of 1.5, indicating a moderate level of Content Knowledge among surveyed teachers. This suggests that on average, teachers possess a satisfactory understanding within their respective subject areas. The responded range scores between 1 to 2 in support of this, indicating while there is variability in knowledge levels, the majority of teachers demonstrate a solid grasp to their subject domains.

The ANOVA test results indicate an F-statistical value of 0.205 and the F-Critical Threshold of 1.918, with a corresponding P-value of 0.999. These findings suggest that there is no significant difference in Content Knowledge levels among teachers across the various subject areas assessed in the study, as the F-statistical value is lower than the critical threshold and the P-value is higher than the typical significant level of 0.05.

Pedagogical Knowledge (PK)

This describes teachers' knowledge of the practices, processes, and methods regarding teaching and learning. It may apply to more specific areas including the understanding of student learning styles, classroom management skills, lesson planning, and assessments (Mkoehler, 2017).

Table 7: Pedagogical Knowledge

	Min, Max	**Mean**	**SD**
Q22. I know how to assess student performance in a classroom.	2, 2	2.0	0
Q23. I can adapt my teaching based-upon what students currently understand or do not understand.	2, 2	2.0	0
Q24. I can adapt my teaching style to different learners.	2, 2	2.0	0
Q25. I can assess student learning in multiple ways.	2, 2	2.0	0
Q26. I can use a wide range of teaching approaches in a classroom setting.	2, 2	2.0	0
Q27. I am familiar with common student understandings and misconceptions.	1, 2	1.8	0.5
Q28. I know how to organize and maintain classroom management.	1, 2	1.8	0.5

Table 7 indicates that the overall mean score of 1.9 across all questions reflects a strong competency in pedagogical practices among the respondents. The non-to-low standard deviations indicate a narrow spread of responses around the mean, implying a consistent level of student understanding in classroom management.

The ANOVA test results revealed an F-statistical value of 0.83, falling below the F-Critical Threshold of 2.57, with a corresponding P-value of 0.558. These findings indicate that there is no significant difference in Pedagogical Knowledge levels among the teachers across the surveyed questions.

Technological Content Knowledge (TCK)

This describes teachers' understanding of how technology and content can both influence and push against each other. TCK involves understanding how the subject matter can be communicated via different edtech offerings, and considering which specific edtech tools might be best suited for specific subject matters or classrooms (Mkoehler, 2017).

Table 8: Technological Content Knowledge

	Min, Max	**Mean**	**SD**
Q29. I know about technologies that I can use for understanding and doing mathematics.	0, 2	1.3	1.0
Q30. I know about technologies that I can use for understanding and doing literacy.	1, 2	1.5	0.8
Q31. I know about technologies that I can use for understanding and doing science.	0, 2	1.0	0.8
Q32. I know about technologies that I can use for understanding and doing social studies.	0, 2	1.0	0.8
Q33. I know about technologies that I can use for understanding and doing visual art.	0, 2	0.8	1.0

Table 8 suggests a moderate level of Technological Content Knowledge among respondents with an overall mean score of 1.1. The standard deviation values indicate variability in responses across different subject areas, with a higher variability in mathematics (SD=1.0) and visual art (SD=1.0).

The ANOVA test results demonstrate an F-statistical value of 0.46, which falls below the F-Critical Threshold of 3.05, with the corresponding P-value of 0.761. These results indicate that there is no significant difference in Technological Content Knowledge levels among the teachers across the surveyed areas.

Pedagogical Content Knowledge (PCK)

This describes teachers' knowledge regarding foundational areas of teaching and learning, including curricula development, student assessment, and reporting results. PCK focuses on promoting learning and on tracing the links among pedagogy and its supportive practices (curriculum, assessment, etc) (Mkoehler, 2017).

Table 9: Pedagogical Content Knowledge

	Min, Max	**Mean**	**SD**
Q34. I can select effective teaching approaches to guide student thinking and learning in mathematics.	0, 2	1.3	1.0
Q35. I can select effective teaching approaches to guide student thinking and learning in literacy.	0, 2	1.5	1.0
Q36. I can select effective teaching approaches to guide student thinking and learning in science.	0, 2	1.3	1.0
Q37. I can select effective teaching approaches to guide student thinking and learning in social studies.	0, 2	1.3	1.0
Q38. I can select effective teaching approaches to guide student thinking and learning in visual arts.	0, 2	1.3	1.0

Table 9 has an overall mean score of 1.3, reflecting a moderate level of Pedagogical Content Knowledge among the respondents. The standard deviation (SD) values of 1.0 indicates larger variability in responses across different subjects. The areas with (SD) values of 1.0 indicate that teachers feel more confident in the subject where they have received more professional training g or have more experience.

The ANOVA test results indicate an F-statistical value of 0.053, which is lower than the F-Critical Threshold of 3.05, with a corresponding P-value of 0.994. These findings suggest that there is no significant difference in Pedagogical Content Knowledge levels among the teachers.

Technological Pedagogical Knowledge (TPK)

This describes teachers' understanding of how particular technologies tools can be deployed alongside pedagogy in ways that are appropriate to the discipline and the development of the lesson at hand (Mkoehler, 2017).

Table 10: Technological Pedagogical Knowledge

	Min, Max	**Mean**	**SD**
Q39. I can choose technologies that enhance the teaching approaches for a lesson.	2, 2	2.0	0
Q40. I can choose technologies that enhance students' learning for a lesson.	2, 2	2.0	0
Q41. My teacher education program has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom.	1, 2	1.5	0.6
Q42. I am thinking critically about how to use technology in my classroom.	0, 2	1.3	1.0
Q43. I can adapt the use of the technologies that I am learning about to different teaching activities.	2, 2	2.0	0
Q44. I can select technologies to use in my classroom that enhance what I teach, how I teach and what students learn.	1, 2	1.8	0.5
Q45. I can use strategies that combine content, technologies and teaching approaches that I learned about in my coursework in my classroom.	1, 2	1.8	0.5
Q46. I can provide leadership in helping others to coordinate the use of content, technologies and teaching approaches at my school and/or district.	1, 2	1.8	0.5
Q47. I can choose technologies that enhance the content for a lesson.	2, 2	2.0	0

Table 10 has an overall mean score of 1.8, indicating a relatively high level of Technological Pedagogical Knowledge among the teacher respondents. The low standard deviation (SD) values of 0.5 to 0.6 suggest a moderate level of agreement regarding the TPK statements. This indicates that teachers generally feel competent in integrating technology effectively in their pedagogical practices.

The ANOVA test results revealed an F-statistical value of 1.25, which is below the F-Critical Threshold of 2.30, with a corresponding P-value of 0.310. This suggests that there are no significant differences in Technological Pedagogical Knowledge levels among teachers across the surveyed areas.

Technology Pedagogy and Content Knowledge (TPACK)

This is the middle integration of these various combinations - Content, Pedagogy, and Technology – in order to create an effective basis for teaching using educational technology (Mkoehler, 2017).

Table 11: Technology Pedagogy and Content Knowledge

	Min, Max	Mean	SD
Q48. I can teach lessons that appropriately combine mathematics, technologies and teaching approaches.	1, 2	1.8	0.5
Q49. I can teach lessons that appropriately combine literacy, technologies and teaching approaches.	1, 2	1.3	0.5
Q50. I can teach lessons that appropriately combine science, technologies and teaching approaches.	1, 2	1.8	0.5
Q51. I can teach lessons that appropriately combine social studies, technologies and teaching approaches.	1, 2	1.5	0.6
Q52. I can teach lessons that appropriately combine visual arts, technologies and teaching approaches.	0, 2	1.3	1.0

Table 11 has an overall mean score of 1.5, indicating a moderate level of Technology Pedagogy and Content among the teacher respondents. The standard deviations (SD) values suggest a range between relatively low to moderate variability (0.5 to 1.0) in the TPACK statements. Overall, while there may be some variability, the data indicates that teachers generally feel capable of integrating technology, pedagogy, and content effectively in their subject teaching practices.

The ANOVA test results revealed an F-statistical value of 0.64, which falls below the F-Critical Threshold of 3.06, with a corresponding P-value of 0.651. These findings suggest that there is no significant difference in Technology Pedagogy and Content Knowledge levels among the surveyed teachers.

Of the four teachers survey in this study, the overall results showed all teachers had a strong use of the TPACK framework and the utilized technology in the classroom effectively and frequently.

GROUP TWO: STUDENT PARTICIPANTS

The second group comprises of nine students in the 5^{th} grade and eight students in the 6^{th} grade, totaling 17 student participants from Starpoint School in grades K5-6. A designated educator served as the point of contact (POC) for the research team, assigning each student a unique identifier to ensure anonymity in survey results. All references to student names were known and monitored by the POC to maintain confidentiality in this comparative study. The digital survey included questions about general demographic questions, comfort level with technology, and their learning experiences with each respective teacher's subject.

Table 12: Demographics of Student Participants

Demographic	Count (N)	Percentage (%)
Grade Level		
5th Grade	9	53%
6th Grade	8	47%
Gender		
Male	11	65%
Female	6	35%
Total	17	100%

Based on the Table 12 demographics, this research study investigated the potential significant differences in students' comfort levels with technology tools by exploring the variations based on grade level and gender.

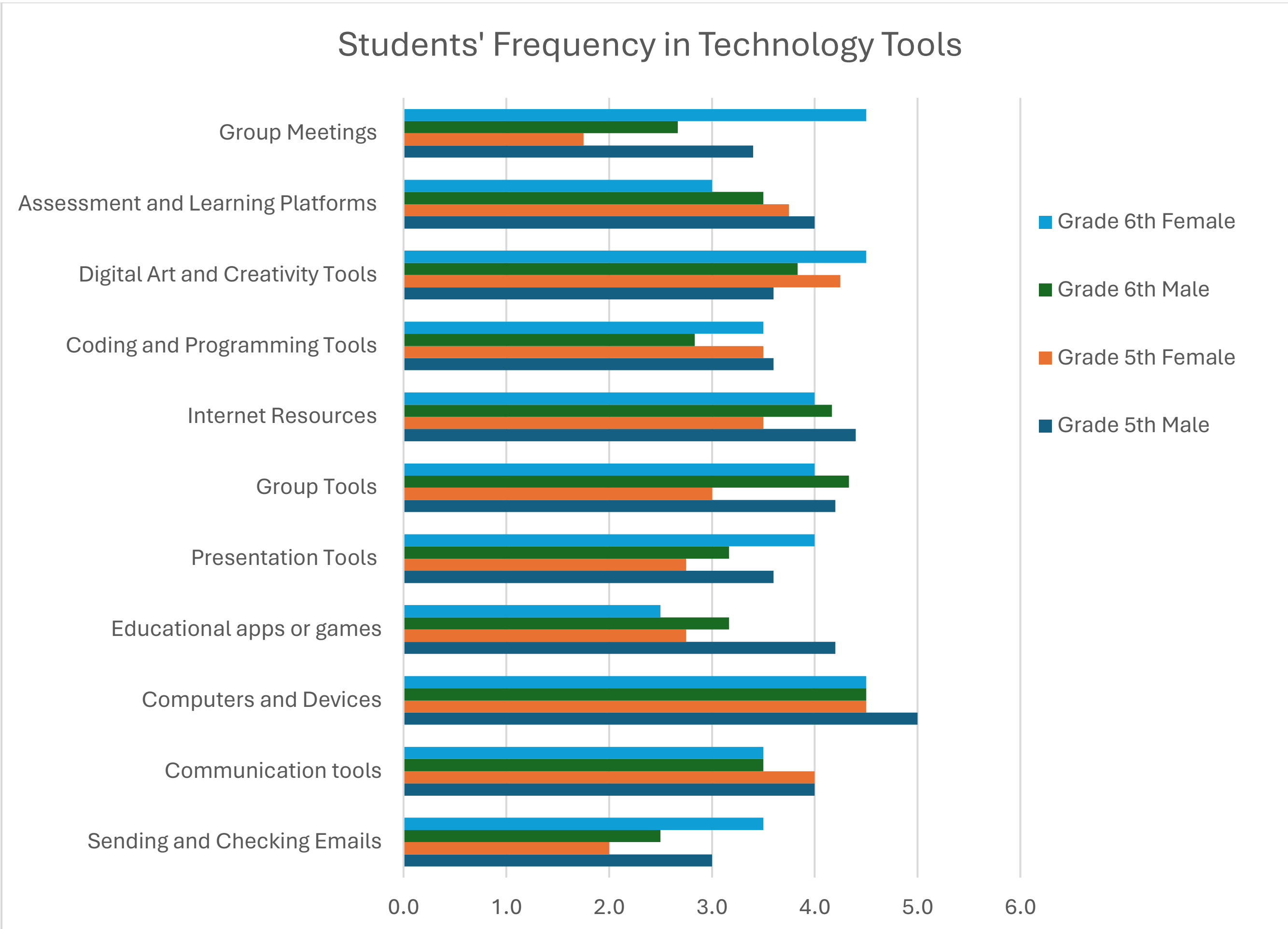
Table 13: Average Comfort Levels with Technology by Grade Levels

Types of technology Tools
Q1. Sending and Checking Emails
Q2. Communication tools (Chatrooms)
Q3. Computers and Devices
Q4. Educational apps or games
Q5. Presentation Tools (PowerPoint, Google Slides)
Q6 Group Tools (Google Docs, Padlet)
Q7. Internet Resources (researching websites, articles)
Q8. Coding and Programming Tools (Scratch, SkriBot)

Q9. Digital Art and Creativity Tools (MS Paint, Photoshop)
Q10. Assessment and Learning Platforms (Kahoot, Quizlet)
Q11. Group Meetings (Zoom, Discord)

Table 13 assesses students’ comfort levels with various technologies by evaluating the frequency with which they utilize different technology tools, both inside and outside the classroom setting. The choices were tailored to an age-appropriate level to ensure optimal comprehension and measured using a five-point Likert scale. The self-rating categories were converted into dummy variables and scored as follows: (1) I never use this, (2) I rarely use this, (3) I sometimes use this, (4) I often use this (4) I use this very frequently. The averages were calculated, and an ANOVA test was performed to see if there were any significant differences between the groups of gender and grade levels.

Figure 13.1: Distribution of Students' Frequency in Technology



SUMMARY

Groups	*Average*	*Variance*
Grade 5th Male	3.9	0.3
Grade 5th Female	3.3	0.8
Grade 6th Male	3.5	0.5
Grade 6th Female	3.8	0.4

ANOVA

F	*P-value*	*F crit*
1.98	0.132	2.84

The overall averages suggest that Grade 5th Male students had the highest average comfort level, followed by Grade 6th Female students, Grade 6th Male students, and Grade 5th Female students. The ANOVA results for the student averages across the 11 questions measured frequency with different technology tools, yielded an F-statistic of 1.98. This value was below the F-Critical of 2.84, corresponding with a P-Value of 0.133. These results indicate no significant difference in the means among the grades and gender groups. Any differences observed are due to random chance rather than meaningful differences.

Table 14: Teacher Technology Usage Evaluation

	Math (M)	**ELAR (M)**	**Visual Art (M)**	**SSS (M)**
5th Grade	2.74	2.74	3.41	2.96
6th Grade	2.83	2.92	3.42	2.83

SUMMARY

Groups	*Average*	*Variance*
Math	2.9	0.004287
ELAR	2.8	0.015475
Visual Art	3.4	4.29E-05
SSS	2.9	0.008402

ANOVA

F	*P-value*	*F crit*
23.96	0.005	6.59

Table 14 refers to students' perception on frequency in each teacher subject in technology usage per semester. The ANOVA results show a significant statistical difference between the means of the group (F=23.86, P = 0.005, F crit = 6.59). Specifically, the Visual Art group mean is higher with significant variance from the other groups.

Table 15: Teacher Content Knowledge Evaluation

	Math (M)	**ELAR (M)**	**Visual Art (M)**	**SSS (M)**
5^{th} Grade	3.07	3.26	3.37	3.48
6^{th} Grade	3.04	3.33	3.42	3.42

SUMMARY

Groups	*Average*	*Variance*
Math	3.06	0.000525
ELAR	3.30	0.002743
Visual Art	3.39	0.001072
SSS	3.45	0.0021

ANOVA

F	*P-value*	*F crit*
37.10	0.002	6.59

Table 15 refers to teacher's content knowledge evaluation by the student class experience. The results suggest that on average, the students rated the Social Studies and Science (SSS) the highest (3.45). The F-Value (37.10) indicates a large difference between group means compared to the variability within groups. This calculated value is greater than the threshold F Critical (6.59), corresponding with the P-value (0.002 < 0.05). These ANOVA results demonstrate statistically significant difference that is not due to random variation across different subject areas.

Table 16: Teacher Pedagogical Evaluation

	Math (M)	**ELAR (M)**	**Visual Art (M)**	**SSS (M)**
5^{th} Grade	2.74	2.74	3.41	2.96
6^{th} Grade	2.83	2.92	3.42	2.83

SUMMARY

Groups	*Average*	*Variance*
Math	2.79	0.004287
ELAR	2.83	0.015475
Visual Art	3.41	4.29E-05
SSS	2.90	0.008402

ANOVA

F	*P-value*	*F crit*
23.96	0.005	6.59

Table 16 indicates that with pedagogical evaluation in the student class experience, Visual Art is averaged the highest (3.41). The ANOVA results indicate a statistically significant difference in rating among the four subject area groups regarding teaching strategies in the class. This is confirmed with the F value (23.96) past the threshold of the F critical (6.59) corresponding with the P value (0.005) smaller than 0.05.

Table 17: Technology Impact on Learning Experience

	Math (M)	**ELAR (M)**	**Visual Art (M)**	**SSS (M)**
5th Grade	3.1	2.8	3.4	3.1
6th Grade	2.9	3.1	4.0	3.3

SUMMARY

Groups	*Average*	*Variance*
Math	2.88	0
ELAR	2.95	0.06028
Visual Art	3.72	0.15432
SSS	3.18	0.00965

ANOVA

F	*P-value*	*F crit*
5.22	0.072	6.59

Table 17 indicates with student evaluation for technology impact, Visual Art was perceived to have the highest impact with the use of technology (3.72). The variance of 0 for the math group suggests that there was complete agreement with no variances among students. The ANOVA results shows that the F value (5.22) is lower than F critical (6.69), corresponding with P value (0.072) > than 0.05. The results support that there is no significant difference in how students perceive the impact of technology on their learning experience across the subject groups being compared.

Table 18: Technology Usage Outside the Classroom

	Math (M)	**ELAR (M)**	**Visual Art (M)**	**SSS (M)**
5th Grade	2.59	2.19	3.07	3.11
6th Grade	2.67	2.67	2.79	2.83

SUMMARY

Groups	***Average***	***Variance***
Math	2.63	0.002743
ELAR	2.43	0.115912
Visual Art	2.93	0.039877
SSS	2.97	0.03858

ANOVA

F	***P-value***	***F crit***
2.73	0.178	6.59

Table 18 refers to student's frequency of technology usage for different aspects of schoolwork (quizzes, projects, assignments) outside the classroom. When asked "*outside of the classroom, do you use technology to help you with schoolwork for this class?"* The average rating shows that SSS has the highest rating (2.97) but when looking at the P-value (0.178), the data analysis confirms that there is no significant statistical difference in terms of technology usage across all four subject groups. The F value (2.73) is much lower than the critical F value (6.59), indicating that the observed difference in group means is more likely due to random variability rather than meaningful differences.

Table 19: Social Media Usage for Class

Grade	Subject	Count(N)	Yes	Yes %
5th Grade				
	Math	9	3	33%
	ELAR	9	1	11%
	Visual Art	9	5	56%
	SSS	9	1	11%
6th Grade				
	Math	8	1	13%
	ELAR	8	1	13%
	Visual Art	8	4	50%
	SSS	8	2	25%

SUMMARY

Groups	*Average*	*Variance*
Math	0.23	0.021701
ELAR	0.12	9.65E-05
Visual Art	0.53	0.001543
SSS	0.18	0.009645

ANOVA

F	*P-value*	*F crit*
8.01	0.036	6.59

Table 19 displays the dispersion of social media usage students use to help with each of their subject-classroom, between grade levels 5th and 6th. When asked *Do you use social media to help you in this class (YouTube, TikTok, Instagram)*? Among the 5th grade, the highest percentage that said yes was Visual Art (56%), Math (33%), ELAR (11%) and SSS (11%). Among the 6th grade, the highest percentage was Visual Art (50%), SSS (25%), ELAR (13%), and Math (11%). When looking at the ANOVA single factor analysis, there is a significant statistical different between the responses of social media usage for each subject matter (F =8.01, F Crit = 6.59, P Value = 0.036 < 0.05).

Table 20: Student Technology Tools Outside the Classroom

Technology Tools	Weighted Score	Frequency (M)	Importance (M)
Q1. Sending & Checking Emails	**2**	**2.65**	**5.29**
Q2. Communication Tools (chatrooms)	**2**	**3.76**	**7.53**
Q3. Computers & Devices	**5**	**4.65**	**23.24**
Q4. Educational Apps or games	**4**	**3.29**	**13.18**
Q5. Presentation tools (PP, Google Slides)	**4**	**3.12**	**12.47**
Q6. Group Tools (Google Docs)	**3**	**3.94**	**11.82**
Q7. Internet Resources (Researching Websites)	**5**	**4.06**	**20.29**
Q8. Coding & Programming Tools	**4**	**3.29**	**13.18**
Q9. Creativity Tools (Photoshop, MS Paint)	**4**	**3.88**	**15.53**
Q10. Assessment Platforms (Kahoot, Quizlet)	**3**	**3.65**	**10.94**
Q11. Group Meetings (Zoom, Discord)	**3**	**2.88**	**8.65**

Table 20 exhibited students' perception of their technology frequency in their self-assessment of use from a scale 1-5. The Mean in frequency is across all 17 students' responses for each technology tool. Each technology tool was assigned a weighted score, as indicated, and multiplied by the individual student's responses to display the weighted score for overall importance alongside frequency. The frequency (unweighted scores) and importance (weighted scores) is considered for analyzation in direct correlation, apart from the tools "Sending & Checking Emails" and "Group Meetings" since the frequency score fell below the threshold score of 3.

Table 21: Pearson Correlation (r) in Students' Frequency & Importance

Technology Tools	**Unweighted Scores (M)**	**Weighted Scores (M)**
Communication Tools	3.76	7.53
Computer & Devices	4.65	23.24
Educational Games	3.29	13.18
Presentation Tools	3.12	12.47
Group Tools	3.94	11.82
Internet & Resources	4.06	20.29
Coding & Programming	3.29	13.18
Creativity Tools	3.88	15.53
Assessment Platforms	3.65	7.29

Coefficient (r)	0.62

Table 21 indicates that there is a positive moderate relationship ($0.3 < r < 0.7$) between the students' frequency with different technology tools (unweighted score) and the perceived importance (weighted score) outside of the classroom setting. An assumption can be made that the frequency of use is correlated to the students' perception of importance. With the weighted Mean at 13.84 and Standard Deviation of 5.27, the responses uncover that Computers & Devices (23.24), Internet Resources (20.29), and Creativity tools (15.53) were perceived as high-importance tools. This proves that hypothesis 1a: *There is a positive relationship between students' frequency use of technology tools and students' perceived importance of tools outside the classroom,* was accepted.

Table 22: Subject Teachers' Self-Assessment in TK, CK, PK

Subject	A (SSS)	B (Art)	C (ELAR)	D (Math)
TK	4.0	4.0	3.8	3.5
CK	4.0	4.0	4.0	4.0
PK	4.0	3.9	3.9	4.0

Table 22 indicates the mean scores of all four subject teachers in their self-assessment (ranged from 0-4) for each area in technology knowledge (TK), content knowledge (CK), and Pedagogy knowledge (PK).Given the min (0) and max (4), the data indicates that each subject teacher rates themselves highly across each competency suggesting that teachers perceive themselves as proficient in using and integrating technology in their teaching practices. The high self-assessment is a possible predictor of their teaching efficiency, and in turn, influences students' perceptions in their frequency and importance of technology usage in and outside the classroom. This indicates that hypothesis 1b: *There is a positive relationship between teacher level of Technology Knowledge (TK) and student frequency of utilizing technology tools outside the class classroom,* was accepted.

Table 23: Student Assessment of Each Teacher's TK, CK, PK

SSS	TK	CK	PK	*F*	*P-value*	*F crit*
Q1	**3.82**	**3.53**	**3.53**	0.13	0.88	5.14
Q2	**3.18**	**3.29**	**3.29**			
Q3	**3.59**	**3.53**	**3.53**			

ART	TK	CK	PK	*F*	*P-value*	*F crit*
Q1	**2.41**	**3.35**	**3.35**	0.90	0.46	5.14
Q2	**2.06**	**3.35**	**3.35**			
Q3	**4.00**	**3.47**	**3.47**			

ELAR	TK	CK	PK	*F*	*P-value*	*F crit*
Q1	**3.53**	**3.47**	**3.47**	1.21	0.36	5.14
Q2	**2.71**	**3.00**	**3.00**			
Q3	**2.18**	**3.41**	**3.41**			

MATH	TK	CK	PK	*F*	*P-value*	*F crit*
Q1	**3.88**	**3.29**	**3.29**	0.14	0.88	5.14
Q2	**3.24**	**2.94**	**2.94**			
Q3	**2.53**	**2.94**	**2.94**			

Table 23 demonstrates the Mean scores of the students' responses across TK, CK, and PK when assessing the competencies of each subject – teacher. An important note is that a post-test was completed to eliminate certain questions for each competency when the student responses fell below a certain threshold number, targeting the questions that held more relevancy to the context of the classroom. The P-Value and F-Stat scores indicate that there is no statistically significant difference between the TK, CK, and PK responses across subject classrooms, implying an alignment in teaching strategies among teachers. This proves that hypothesis 2a*: There is no* *significant variance between the students' responses in each subject classroom in the TPACK framework (TK, CK, PK),* was accepted.

Table 24: Student Self-Assessment in TPACK to Student Learning Experience

Subject (SSS)	CK	PK	Experience
	3.33	3.40	4.00
	3.00	2.80	3.00
	3.00	3.20	3.00
	4.00	3.60	4.00
	3.33	3.20	4.00
	3.67	2.60	2.00
	4.00	3.40	3.00
	3.33	3.00	2.00
	3.67	3.20	3.00
	3.33	3.40	3.00
	4.00	3.20	4.00
	4.00	3.80	4.00
	3.33	3.20	3.00
	2.67	2.60	2.00
	3.67	3.40	4.00
	3.33	2.80	3.00
	3.00	3.20	3.00

	CK	*PK*	*Experience*
CK	1		
PK	0.58	1	
Experience	0.49	0.75	1

Subject (ART)	CK	PK	Experience
	4.00	3.00	4.00
	3.67	3.60	3.00
	4.00	4.00	3.00
	3.67	3.60	3.00
	3.00	3.60	4.00
	3.00	3.60	3.00
	3.67	3.80	4.00
	3.00	3.20	3.00
	3.00	3.60	4.00
	3.00	3.60	4.00
	3.33	3.00	4.00
	3.67	2.80	4.00
	4.00	4.00	4.00
	2.67	2.80	4.00
	4.00	3.60	4.00
	3.33	3.00	4.00
	2.67	3.40	4.00

	CK	*PK*	*Experience*
CK	1		
PK	0.31	1	
Experience	-0.10	-0.30	1

Subject (ELAR)	CK	PK	Experience
	2.33	3.20	3.00
	3.00	2.40	3.00
	3.33	3.00	3.00
	3.67	3.20	3.00
	3.00	3.00	4.00
	3.67	3.40	1.00
	3.00	3.00	3.00
	3.33	2.80	2.00
	4.00	3.20	3.00
	3.67	2.80	3.00
	3.33	2.40	4.00
	3.33	3.20	4.00
	2.00	2.00	4.00
	3.67	3.40	1.00
	4.00	3.80	4.00
	3.67	3.20	3.00
	3.00	2.80	2.00

	CK	PK	Experience
CK	1		
PK	0.64	1	
Experience	-0.24	-0.27	1

Subject (MATH)	CK	PK	Experience
	3.33	2.80	2.00
	3.00	3.40	3.00
	3.00	3.00	3.00
	3.33	2.60	3.00
	3.33	3.00	4.00
	2.00	1.80	2.00
	3.33	2.80	3.00
	3.33	3.20	4.00
	3.00	2.60	4.00
	2.33	2.60	1.00
	3.00	3.20	4.00
	3.33	3.00	1.00
	3.67	3.00	4.00
	3.00	3.20	3.00
	2.33	2.20	2.00
	3.67	2.80	4.00
	3.00	3.40	4.00

	CK	*PK*	*Experience*
CK	1		
PK	0.59	1	
Experience	0.51	0.45	1

Table 24 presents the student survey result when asked the question "Overall, how much did the use of technology in this class improve your learning experience?" To assess if there was a direct relationship between Content Knowledge, Pedagogy Knowledge, and the student learning experience, a Pearson correlation was performed. Class subjects SSS and MATH revealed a moderate to strong correlation between the responses ($0.3 < r < 0.7$). In contrast, subjects ART and ELAR revealed a weak negative correlation ($-0.7 < r -0.3$). These findings reveal in some instances, there is a strong or weak alignment between Content/Pedagogy Knowledge and overall experience. This indicates that hypothesis 2b*: There is a positive relationship between the utilization of TPACK Framework (TK, CK, PK) in the classroom and the student's learning experience*, was rejected.

Hypothesis Testing:

Different surveys structures were used for Group One: teacher participants and Group Two: student participants. The teacher survey had a 5-point Likert scale, whereas the student survey has a 4-point Likert scale, so the teacher responses had to be converted to match the scale to the student survey. Once the responses were converted into dummy variables, the mean was calculated for the teachers' responses across all relevant questions for each dimension (TK, CK, PK) for each subject classroom. The same process was done calculating the mean for student responses for questions related to each dimension in each subject classroom. The means score was organized in one column for teacher and another for students. Each row corresponds to a teacher-class pair. Using the Correlation function, the statistical tool was utilized to calculate the Pearson correlation between the Teacher and Student responses to evaluate the given relationship.

RESULTS

Group One: Teacher Participants

Descriptive Statistics and ANOVA Single Factor data analysis were utilized to capture the Min, Max, Mean, Standard Deviation, F value, F critical, and P-Value for Group One: Teacher Participants. The survey included 12 demographic questions and 52 self-assessment questions across the seven TPACK domains. Each question uses the following five-level Likert scale: (-2) Strongly Disagree, (-1) Somewhat Disagree, (0) Neither Agree nor Disagree, (1) Somewhat Agree, (2) Strongly Agree. Across each dimension of the seven dimensions (TK, CK, PK, TCK, PCK, TPK, TPACK), the range of responses among the four teacher participants never fell below (0) Neither Agree nor Disagree. For each of the seven dimensions, the F statistical value never exceeded the F Critical, corresponding to a P-Value that never went below the standard 0.05.

Group Two: Student Participants

ANOVA Single Factor Analysis was utilized to capture the Mean, variances, F value, F critical and P value for Group Two: Student Participants. The survey included 5 demographic questions and 11 self-assessment questions across the domains of:

1.) Personal Frequency of Technology Usage

2.) Evaluation of Teacher Technology Usage

3.) Evaluation of Teacher Content Knowledge

4.) Evaluation of Teacher Pedagogical Knowledge

5.) Technology Impact on Learning Experience

6.) Technology Usage Outside of the Classroom

7.) Social Media Usage for Class

The Likert Scale varied from a five-level scale to a four-level scale to consider the frequency of the question being asked. Based on the ANOVA results, there was no statistical difference between genders and grade level for Personal Frequency of Technology Usage (1.), ($F = 1.98$, P Value $=0.132$, F crit$= 2.84$). For Evaluation of Teacher Technology Usage (2.), there is significant statistical difference between the means of the group ($F=23.86$, $P = 0.005$, F crit $= 6.59$). For Evaluation of Teacher Content Knowledge (3.), there was statistically significant difference ($F = 37.10$, $P = 0.002$, F crit $=6.59$). For Evaluation of Teacher Pedagogy (4.), there was a significant difference ($F= 23.96$, $P = 0.005$, F Crit $= 6.59$). For Technology Impact on Learning Experience (5.), there was no significant statistical difference ($F = 5.22$, $P = 0.072$, F crit = 6.59). For Technology Usage Outside of the Classroom (6.), there is no significant difference (F= 2.73, P = 0.178, F crit = 6.59). For Social Media Usage for Each Classroom (7.), there was significant difference (F=8.01, P= 0.036, F crit = 6.59).

DISCUSSION

Group One: Teacher Participants

The results for Group One, comprising of four teacher participants, showed no statistically significant differences across each dimension of the TPACK framework (TK, CK, PK, TCK, PCK, TPK, TPACK). This lack of significant differences can be attributed to several factors. Firstly, it can be assumed that the teachers possessed similar technical skills, technical knowledge, and technical experience, leading to consistent and positive responses in the survey questions. However, it is important to note the potential limitations of this analysis due to the small sample size (n=4) of the teacher participants. With such a limited sample, there is an increased risk of error in detecting significant differences among the group. The findings may have limited generalizability to larger populations of licensed instructors and there may be challenges in rejecting the null hypothesis in ANOVA due to limited statistical power.

Group Two: Student Participants

In contrast, Group Two, consisting of 17 student participants in grades K5-6, exhibited more variability in their responses. While there was no statistical difference between genders and grade level for Personal Frequency of Technology Usage, the overall mean scores suggest that Grade 5th Male students had the highest average comfort level with each technology tool. The significant difference in Evaluation of Teacher Technology Usage indicates that the Visual Art class had a higher mean with significant variance from the other groups, followed by Math and SSS with the same mean score. This difference can be attributed to the Visual Art class utilizing art through technology tools (i.e. Photoshop). For Evaluation of Teacher Content Knowledge (3.), results suggested a significant difference with SSS rated the highest mean score. Another statistically significant difference in Evaluation of Teacher Pedagogy shows that Visual Art had the highest average, followed by SSS. However, there was no significant difference in Technology Impact on Learning Experience or Technology Usage outside the classroom across all four classroom subjects. Finally, there was significant difference in Social Media usage for each subject classroom, with both grade levels listing Visual Art with the highest average (K5= 56%, K6 = 50%). When looking at second highest average for social media usage, 5th grade listed Math as second highest (Math = 33%, SSS = 11%), but 6th grade listed SSS as second highest (Math = 13%, SSS= 25%).

PRACTICAL IMPLICATION

As educators strive to improve their teaching initiatives in the classroom, it becomes important to explore the importance of theoretical frameworks on classroom practices.

Effective Education Strategies: Understanding the effectiveness of technology integration, teaching methodologies, and content knowledge, regardless of the subject being taught, enables teachers to adopt new strategies and tools to enhance their teaching approaches, potentially leading to improved outcomes for students.

Technological Situations: These findings are valuable for teachers who face challenges related to technological integration. Sharing the outcomes from this study can provide other institutions with insights to address the need for integrating a form of technology tools to improve teaching effectiveness in the classroom.

Student Experience: Students can indirectly benefit from the research findings through increased motivation, comprehension, and integrated learning experience from an effective learning environment.

LIMITATIONS

This study encompasses several important limitations for consideration. These include the small sample size of teachers (n=4) and students (n=17), the non-randomized selection of participants, and the reliance on self-assessment through surveys. Context understanding could have been an additional limitation with selected few 5th and/or 6th grade students unable to comprehend the full context of certain questions. It's crucial to acknowledge these limitations as they may impact the study's findings and their generalizability.

One notable limitation is the potential challenges in detecting significant differences among groups due to the small sample size. This limitation can lead to limited generalizability of the findings to larger populations of licensed instructors and students. Additionally, the small sample size may hinder the ability to reject the null hypothesis in ANOVA analysis, emphasizing the importance of statical power considerations. Another limitation could be the questions for students assessing technological knowledge. Rather than asking high-level contextual questions of technology use, the survey asked specific technology tools, which skewered the responses for TPACK in comparison to learning experience.

To address these limitations and enhance the robustness of the study, future research should consider employing a larger sample size with a revision of the survey questions. Qualitative analysis methods can also complement quantitative assessments by providing deeper insights into the participants self-assessment responses. These recommendations aim to strengthen the study's validity and contribute to a more comprehensive understanding of the research topic.

CONCLUSION

Thie findings in this comparative study suggest an interesting disparity between the self-assessment of teacher participants and the evaluation provided by students. While the teachers generally rated themselves positively in terms of technology knowledge, content knowledge, and pedagogical knowledge, students' responses revealed a different perspective.

Hypothesis 1a: *There is a positive relationship between students' frequency use of technology tools and students' perceived importance of tools outside the classroom.*

Hypothesis 1b: *There is a positive relationship between teacher level of Technology Knowledge (TK) and student frequency of utilizing technology tools outside the class classroom.*

Hypothesis 1a and 1b were accepted with the Pearson correlation assessing the unweighted and weighted scores in table 21, demonstrating a moderate correlation with frequency and weighed importance of technology tools. Table 22 illustrates how teachers highly assessed themselves, showing an alignment to students high rating in their technology perception, which may indicate a consensus on the importance of these tools. Further investigation is recommended to investigate causation between the assessments.

Hypothesis 2a*: There is no significant variance between the students' responses in each subject classroom in the TPACK framework (TK, CK, PK).*

Hypothesis 2b*: There is a positive relationship between the utilization of TPACK Framework (TK, CK, PK) in the classroom and the student's learning experience.*

Hypothesis 2a was accepted yet hypothesis 2b was rejected. Table 23 presents how there was no statistically significant difference among the three competencies (TK, CK, PK) across the subject classrooms, proving alignment in the students' assessment towards their teachers. Table 24 showed unique results where ART and ELAR had a negative weak relationship ($-0.7 < r < -0.3$) when comparing Content Knowledge and Pedagogy Knowledge to learning experience. This doesn't imply that the students had low learning experience in relation to the competencies but rather the responses which were rated highly don't have a correlation to the responses for Content knowledge and Pedagogy knowledge. Further investigation is recommended to assess the relationships to learning experiences.

In conclusion, this study encompasses digital literacy in education, highlighting the implementation of technology within a classroom setting. Through a comprehensive survey for both teachers and students, along with thorough statistical analysis, different key findings emerged from both group perspectives. The teachers' responses, measured by TPACK, showcased a consistent alignment across various dimensions without significant deviations. Notably, student evaluations of teacher technology usage, content knowledge, and pedagogy demonstrate statistically significant differences, indicating a nuances perception for the 5^{th} and 6^{th} grade in how technology impacts their learning experiences. However, there is a need for further exploration of causation between both groups and a need to redefine the questions related to teachers TK for student assessment. Ultimately, this study emphasizes the importance of connecting a theoretical framework to a practical application to foster digital literacy skills and enhance the classroom initiatives to prepare for the technology-driven world.

Appendix A: Survey of Preservice Teachers' Knowledge of Teaching and Technology

Denise A. Schmidt, Evrim Baran, and Ann D.
Thompson Center for Technology in
Learning and Teaching
Iowa State University

Matthew J. Koehler, Punya Mishra, and Tae
Shin Michigan State University

Version 1.1: (updated September 1, 2009). This survey was revised to reflect research results obtained from its administration during the 2008-2009 and 2009-2010 academic years. This document provides the latest version of the survey and reports the reliability scores for each TPACK domain. (This document will be updated as the survey is further developed).

Version 1.2: (updated January 2024). This version has been modified to align with the target demographic of primary and secondary school teachers.

Start of Survey

Welcome educators!

We're thrilled to invite you to participate in our 15-minute survey. For ease of access, please take this on your laptop or desktop. Throughout this survey, we'll be delving into various aspects of teaching, including how technology, teaching methods, and subject matter knowledge intersect. Don't worry if you haven't heard of the TPACK framework before. This is a tool designed to help us understand how these three elements - Technology, Methodology, and Content Knowledge - work together in a classroom.
Our goal is to uncover what teaching methods work best, regardless of the subject you teach, the technology you use, or your preferred teaching style. Your input is invaluable and will greatly contribute to our understanding of effective classroom strategies. Thank you for your participation in this endeavor.

DEMOGRAPHIC INFORMATION

1. Your Last Name

2. Gender
    a. Female
    b. Male

3. Age range
    a. 18-22
    b. 23-26
    c. 27-32
    d. 32+

4. Years in teaching
    a. Less than 5 years
    b. 5-10 years
    c. 11-20 years
    d. More than 20 years

5. Major
    a. Early Childhood Education (ECE)
    b. Elementary Education (ELED)
    c. Secondary Education
    d. Other
6. What subjects do you currently teach?

7. What grade levels do you currently teach?

8. Area of Specialization
    a. Art
    b. Early Childhood Education Unified with Special Education
    c. English and Language Arts
    d. Foreign Language
    e. Health
    f. History
    g. Instructional Strategist: Mild/Moderate (K8) Endorsement
    h. Mathematics
    i. Music
    j. Science-Basic
    k. Social Studies
    l. Speech/Theater
    m. Other

9. Where did you learn the technology applied in your classroom setting?
    a. Self-taught
    b. Off-campus seminars
    c. School sponsored conferences
    d. School education course
    e. Other

10. Please prioritize the learning styles of the technology utilized in your classroom according to frequency of use. Rank them from most to least frequent. If you've only selected one option in the previous section, please place "Not applicable" at the top.
    a. Self-taught

b. Off-campus seminars
c. School sponsored conferences
d. School education course
e. Other
f. Not applicable

11. How often do you train or revise on the technology utilized in your classroom?

	Never	Sometimes	Most of the time	Frequently
I keep myself updated in my knowledge of the technology utilized.				

12. How often do you spend looking at new technology being incorporated in the classroom to be better prepared as an educator?

	Never	Sometimes	Most of the time	Frequently
I keep myself updated on new emerging technology that applies to the classroom setting.				

Technology is a broad concept that can mean a lot of different things. For the purpose of this questionnaire, technology is referring to digital technology/technologies. That is, the digital tools we use such as computers, laptops, iPods, handhelds, interactive whiteboards, software programs, etc. Please answer all of the questions and if you are uncertain of or neutral about your response you may always select "Neither Agree or Disagree"

	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
TK (Technology Knowledge)					
1. I know how to solve my own technical problems.					
2. I can learn technology easily.					
3. I keep up with important new technologies.					
4. I frequently play around the technology.					
5. I know about a lot of different technologies.					
6. I have the technical skills I need to use technology.					
CK (Content Knowledge)					
Mathematics					
7. I have sufficient knowledge about mathematics.					
8. I can use a mathematical way of thinking.					
9. I have various ways and strategies of developing my understanding of mathematics.					
Social Studies/Science					
10. I have sufficient knowledge about social Studies and Science					
11. I can use a historical way of thinking.					
12. I have various ways and strategies of developing my understanding of social Studies and Science					
Visual Art					
13. I have sufficient knowledge about Visual Art.					
14. I can use an artistic way of thinking.					
15. I have various ways and strategies of developing my understanding of visual art.					
Literacy					
16. I have sufficient knowledge about literacy.					
17. I can use a literary way of thinking.					
18. I have various ways and strategies of developing my understanding of literacy.					

PK (Pedagogical Knowledge)					
19. I know how to assess student performance in a classroom.					
20. I can adapt my teaching based-upon what students currently understand or do not understand.					
21. I can adapt my teaching style to different learners.					
22. I can assess student learning in multiple ways.					
23. I can use a wide range of teaching approaches in a classroom setting.					
24. I am familiar with common student understandings and misconceptions.					
25. I know how to organize and maintain classroom management.					

PCK (Pedagogical Content Knowledge)					
26. I can select effective teaching approaches to guide student thinking and learning in mathematics.					
27. I can select effective teaching approaches to guide student thinking and learning in literacy.					
28. I can select effective teaching approaches to guide student thinking and learning in science and social studies.					
29. I can select effective teaching approaches to guide student thinking and learning in visual art.					
TCK (Technological Content Knowledge)					
30. I know about technologies that I can use for understanding and doing mathematics.					
31. I know about technologies that I can use for understanding and doing literacy.					
32. I know about technologies that I can use for understanding and doing science and social studies.					
33. I know about technologies that I can use for understanding and doing visual art.					

TPK (Technological Pedagogical Knowledge)					
34. I can choose technologies that enhance the teaching approaches for a lesson.					
35. I can choose technologies that enhance students' learning for a lesson.					
36. My teacher education program has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom.					
37. I am thinking critically about how to use technology in my classroom.					
38. I can adapt the use of the technologies that I am learning about to different teaching activities.					
39. I can select technologies to use in my classroom that enhance what I teach, how I teach and what students learn.					
40. I can use strategies that combine content, technologies and teaching approaches that I learned about in my coursework in my classroom.					
41. I can provide leadership in helping others to coordinate the use of content, technologies and teaching approaches at my school and/or district.					
42. I can choose technologies that enhance the content for a lesson.					

TPACK (Technology Pedagogy and Content Knowledge)					
43. I can teach lessons that appropriately combine mathematics, technologies and teaching approaches.					
44. I can teach lessons that appropriately combine literacy, technologies and teaching approaches.					
45. I can teach lessons that appropriately combine science, social studies, technologies and teaching approaches.					
46. I can teach lessons that appropriately Combine Visual art, technologies and teaching approaches.					

Appendix B: Survey of Student's Knowledge of Teaching and Technology

Start of Survey

Welcome, students! We're excited to have you join us for this survey! You will need to complete this survey in each classroom for each teacher. We want to learn about your experiences in class and how you use different technology tools in each subject. Your opinions are very important to us.Thanks for helping us out! Let's get started!

DEMOGRAPHIC INFORMATION

1. What is your student ID?

2. What is the last name of your teacher?

3. What subject dose this teacher teach?

4. What is your grade level?
   a. 5th grade
   b. 6th grade

5. What is your gender?
   a. Male
   b. Female
   c. Prefer not to say

6. Please select your comfort level with each of these technologies. If you already answered this question, you may skip this question and continue.

	I never use this	I rarely use this	I sometimes use this	I often use this	I use this frequently
1. Sending and Checking emails					
2. Communications tools (chatrooms)					
3. Computers and Devices					
4. Educational apps or games					
5. Presentation Tools (PowerPoint, Google Slides)					
6. Group Tools (Google Docs, Padlet)					
7. Internet Resources (researching website)					

8. Coding and programming Tools (Scratch, SkriBot)					
9. Digital Art and Creativity Tools (MS Paint, Photoshop)					
10. Assessment and Learning Platforms (Kahoot, Quizlet)					
11. Group Meetings (Zoom, Discord)					

7. **TK (Technology Knowledge)** Please select how often per semester your teacher used the technology tools listed below in this class.

	Never	Sometimes	Most of the time	Always
1. Email for instruction				
2. Smart Board or Whiteboard				
3. Online Discussion Platform				
4. Educational apps or games				
5. Screen Mirroring: Websites or other applications				
6. Group Tools (Google Docs, Notability)				
7. Group Meeting Tools (Zoom, Discord)				

8. **CK (Content Knowledge)** Please select your answer based on your experience with your teacher's knowledge in this class.

	Never	Sometimes	Most of the time	Always
1. My teacher displays a lot of knowledge in this subject.				
2. My teacher explains difficult concepts in a way that is easy for me to understand.				
3. My teacher is great at clarifying questions in the classroom.				
4. I am confident I could teach someone else if they asked for help.				
5. I feel better prepared to use the technology tools outside of the classroom.				

9. **PK (Pedagogical Knowledge)** Please select your answer based on your experience with your teacher's strategies in this class.

	Never	Sometimes	Most of the time	Always
1. My teacher is very excited about teaching us technology tools.				
2. My teacher encourages critical thinking and problem-solving during class activities.				
3. My teacher provides constructive feedback to help me improve.				
4. My teacher's teaching style makes it easy for me to remember the lessons.				
5. I enjoy the use of technology in the classroom.				

10. Overall, how much did the use of technology in this class improve your learning experience?

	Not at all	Slightly	Moderately	Always
1. My learning experience in this class has improved with the technology that we used				

11. Outside of the classroom, do you use technology to help you with schoolwork for this class?

	Never	Sometimes	Most of the time	Always
1. To review for exams/ quizzes				
2. To help with homework/projects				
3. To complete in-class assignments				

12. Do you use social media to help you in this class? (such as Instagram, Tik Tok, YouTube)
   a. Yes
   b. No

References

Ary, D., Jacobs, L. C., Sorensen, C., & Walker, D. A. (2010). Introduction to research in education. Cengage Learning.

Cator, K. (2022, May 13). *Closing the digital learning gap*. Digital Promise. https://digitalpromise.org/2019/01/09/closing-the-digital-learning gap/?gclid=Cj0KCQjwx5qoBhDyARIsAPbMagCeyyC-gA29IKcAXSoLQ57Q2PaN5HytawK82or8nwb40RvFYV4Zx_UaArZMEALw_wcB

Creswell, J. W. (2007). Qualitative inquiry and research design: Choosing among five approaches. Sage Publications.

Dybå, T., & Dingsøyr, T. (2008). Empirical studies of agile software development: A systematic review. Information and Software Technology, 50(9-10), 833-859.

Ertmer, P. A. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration. Educational Technology, Research and Development, 53(4), 25- 39

Eshet-Alkalai, Y., & Amichai-Hamburger, Y. (2004). Experiments in digital literacy. CyberPsychology & Behavior, 7(4), 421-429.https://doi.org/10.1089/1094931041774613.

Grant, M. J., & Booth, A. (2009). A typology of reviews: An analysis of 14 review types and associated methodologies. Health Information & Libraries Journal, 26(2), 91-108.

Harris, J. B., & Hofer, M. J. (2011). Technological Pedagogical Content Knowledge (TPACK) in Action. Journal of Research on Technology in Education, 43(3), 211–229. https://doi.org/10.1080/15391523.2011.10782570

Harris, J. N., & Hoefer, M. J. (2017). Tpack stories - W&M ScholarWorks - William & Mary. “TPACK Stories”: Schools and School Districts Repurposing a Theoretical Construct for Technology-Related Professional Development. https://scholarworks.wm.edu/cgi/viewcontent.cgi?article=1077&context=educationpubs

Harris, J. B. (2020, November 5). Teaching with technologies: Is Tpack still relevant?. YouTube. https://www.youtube.com/watch?v=2tlA9Ck3sbE&t=1176s

Jang, S. J., & Tsai, M. F. (2012). Exploring the TPACK of science and math teachers using interactive whiteboards in Taiwan. Australasian Journal of Educational Technology, 28(8), 1410-1427.

Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge? Contemporary Issues in Technology and Teacher Education, 9(1), 60-70.

Martin, A. (2005). DigEuLit – a European framework for digital literacy: a progress report. Journal of eLiteracy,2, 130-136.

Martin, A. (2008). Digital literacy and the “digital society”. In C. Lankshear & M. Knobel (Eds.), Digital Literacies: Concepts, Policies and Practices (pp. 151-176). PeterLang.

Mishra, P. (2020, November 5). *Teaching with technologies: Is Tpack still relevant?*. YouTube. https://www.youtube.com/watch?v=2tlA9Ck3sbE&t=1176s

Mishra, P., & Koehler, M.J. (2006). Technological pedagogical content knowledge: A framework for integrating technology in teacher knowledge. Teachers College Record, 108(6), 1017-1054

Mkoehler. (2017, June 9). Tpack explained. TPACK.ORG. https://matt-koehler.com/tpack2/tpack-explained/

Niess, M. L., Ronau, R. N., Shafer, K. G., Driskell, S. O., Harper S. R., Johnston, C., Browning, C., Özgün-Koca, S. A., & Kersaint, G. (2009). Mathematics teacher TPACK standards and development model. Contemporary Issues in Technology and Teacher Education, 9(1), 4-24.

Patton, M.Q. (1990). Qualitative evaluation and research methods (2nd ed.). Sage Publications.

PowerSchool. (2022, April 20). The TPACK Framework Explained (With Classroom Examples). Powerschool.com. https://www.powerschool.com/blog/the-tpack-framework-explained-with-classroom-examples/

Reddy, P., Chaudhary, K., & Hussein, S. (2023). A digital literacy model to narrow the digital literacy skills gap. Heliyon, 9(4).

Ribble, M. (2011). Digital Citizenship in Schools. International Society for Technology in Education (ISTE). Retrieved April 5, 2022 from https://www.researchgate.net/publication/340467688_Digital_Citizenship_in_Schools_Second_Edition

Rosenberg, J. M., & Koehler, M. J. (2015). Context and Technological Pedagogical Content Knowledge (TPACK): A systematic review. Journal of Research on Technology in Education, 47(3), 186–210. https://doi.org/10.1080/15391523.2015.1052663

Saijal. (2023, September 1). *Digital literacy in classrooms for equipping children for the future*. STEMpedia. https://thestempedia.com/blog/digital-literacy-in-classrooms-for-equipping-children-for-the-future/

Schmid, M., Brianza, E., & Petko, D. (2020). Developing a short assessment instrument for Technological Pedagogical Content Knowledge (TPACK.xs) and comparing the factor structure of an integrative and a transformative model. Computers & Education, 157, 103967. https://doi.org/10.1016/j.compedu.2020.103967

Shulman, L. (1986). Those who understand: Knowledge growth in teaching. Educational Researcher, 15(2), 4-14.