Exploring the Impact of Technology Integration at the Elementary Level

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Abstract

This paper explores the impact of technology integration at the elementary level, focusing on measuring learning, benefits and challenges, attention, and technology. By examining existing research, this literature review highlights the importance of effective technology implementation in providing students with enhanced engagement, personalized learning, and the development of critical thinking and problem-solving skills. It also addresses challenges such as access to technology, teacher training, and the need for digital citizenship education. The paper concludes with recommendations for future research from educators and policymakers and a discussion summarizing the key takeaways, and an action plan for future instruction.

Keywords: effective technology integration, engagement, potential benefits

Exploring the Impact of Technology Integration at the Elementary Level

This paper explores technology's impact on student learning outcomes in elementary education. Technology in elementary education is gaining popularity due to its potential to enhance students' learning experiences. In this context, technology integration refers to the deliberate and purposeful incorporation of technology tools, resources, and practices into the teaching and learning process. It goes beyond using technology as a mere supplement and instead focuses on seamlessly integrating technology into all aspects of the learning environment. This integration enables students to develop digital literacy skills, critical thinking, and creativity. By leveraging various technological tools such as computers, tablets, interactive whiteboards, educational software, and online resources, technology integration in elementary education aims to facilitate personalized and collaborative learning experiences, foster inquiry-based learning, and equip students with essential 21st-century skills for their future success.

There is still a need for future research that will explore the benefits and challenges of implementing technology in educational settings. The findings of this thesis paper will provide insights for educators, policymakers, and researchers on the benefits and challenges of technology integration in elementary education. Ultimately, this thesis paper aims to contribute to the ongoing dialogue on technology integration in elementary education and provide guidance for effective and responsible implementation.

As a novice educator, I have quickly recognized the significance of technology integration in educational institutions. Every classroom where I have served as a substitute teacher has provided individualized devices for students, sparking my enthusiasm for exploring technology in education. My exposure to technology in academia began during my senior year at Washington State University when classes transitioned entirely online. This experience

heightened my curiosity about the disparities between technology use as a graduate student and its implementation during my student teaching in the traditional classroom setting. Throughout my current role as a long-term substitute, I have encountered numerous barriers and challenges associated with integrating technology in schools. From the onset of my teaching journey, I have been captivated by this subject and driven by many questions surrounding the rapid growth of technology in education.

The recent trend of using technology provides learning opportunities remotely for students. Educators and policymakers are rethinking education and the approach to education and technology implementation. Technology integration in schools will be further accelerated, and online education will become a significant learning component (Mcdiarmid & Zhao, 2022). The questions posed by Mcdiarmid and Zhao, 2022 ask if we are preparing students to both take advantage of what emerging technology offers and recognize the potential dangers that these technologies offer and recognize the potential dangers of technology. Systematic actions must be taken to undo the "grammar of schooling."

Focal Questions

- How can the integration of technology enhance the learning experience of elementary school students?
- What potential negative impacts are there for technology integration?
- How can the use of technology in elementary education help to bridge the digital divide and promote equity in education?

Literature Review

This literature review will explore various aspects of technology implementation at the elementary level. The literature review will address these three themes: measuring learning,

benefits and challenges, and attention and technology. The literature review will examine research on the impacts of technology on student achievement, engagement, and motivation. Furthermore, the literature review will explore the challenges and barriers schools and educators face in implementing technology and discuss potential strategies for overcoming them.

Measuring Learning

Measuring learning and technology implementation in elementary schools involves assessing the effectiveness of technology use in enhancing students' educational outcomes. The common approaches to measuring learning in technology implementation include achievement tests, skill-based assessments, observations, rubrics, and pre- and post-implementation surveys. Quantitative and qualitative approaches to measuring learning concerning technology implementation can provide a more comprehensive understanding of the impact of technology on learning outcomes at the elementary level.

Solé-Beteta (2012) examines how teachers gauge student engagement in the classroom through immediate student feedback regarding their learning experiences. The article emphasizes different dimensions of student engagement that researchers measure, including academic, behavioral, emotional, and cognitive aspects. Notably, the findings highlight the potential of digital features in virtual learning environments to assist teachers and experts in measuring student engagement. This article aims to provide teachers with valuable insights for adapting their lesson plans to sustain the desired level of student engagement. The next paragraph addresses the methods that can be used for measuring learning.

Buntins' (2012) report focuses on measuring student engagement in higher education and the varying definitions and descriptions provided by educational researchers. The study

utilizes various measurement tools, such as questionnaires, behavioral traces, observation-based methods, and interviews, to assess student engagement. However, the report concludes that further research is needed to understand better how the measurement of student engagement can be effectively operationalized and validated. Next, the literature discusses how to engage students and how to measure that engagement.

Cents-Boonstra (2019) conducted a study utilizing classroom observation to examine how teachers apply the Self-Determination Theory in their instructional practices. The findings revealed that teachers who provided motivation and support to their students exhibited the highest levels of engagement. Student engagement, encompassing school and class participation, comprises three key aspects: emotional, behavioral, and cognitive engagement. Various tools were employed in this study to measure student engagement, including observing students' attention, effort, verbal participation, and persistence during lessons or activities.

Next, the literature addresses the connection between technology integration and the measurement of student learning. This research highlights the need to shift the focus from considering students as digital natives to understanding them as digital learners, as supported by empirical evidence There is a crucial need to critically examine current educational practices to support student engagement in digital learning environments effectively. Understanding the relationship between learning and technology highlights the varied instruments that can be employed to measure learning outcomes, including self-reports, interventions, and observational reports. With this information from technology, teachers can make informed adjustments to their teaching methods and lesson planning to optimize student learning experiences (Autry & Berge, 2011 as cited in Wallace-Spurgin,

2020). Next the literature reviews how to effectively measure student engagement and learning.

Solé-Beteta (2022) explores data-driven approaches to effectively measure and quantify student engagement within synchronous virtual learning environments. While in-person instruction enables teachers to employ formative assessments to gauge immediate feedback and understanding, this study proposes a methodology specifically tailored to measure student engagement as a crucial performance indicator in the learning process.

Solé-Beteta (2022) suggests various strategies to foster student attention and engagement. Among these strategies is the promotion of task relevance, which involves incorporating alternative activities like gamification to support lessons. One can comprehensively measure and assess student engagement by considering academic association, behavioral components, and emotional and cognitive thought processes. Similarly, Wallace-Spurgin, 2020 focuses on effective technology integration.

Wallace-Spurgin's, 2020 explores the effectiveness of technology integration and the measurement of student cognitive engagement. A crucial aspect of preparing students for the future involves ensuring accessibility to devices and providing adequate teacher training in technology and teaching methodologies. Collaborative efforts are necessary to change pedagogy, instructional methods, curriculum design, and assessment practices. School districts encounter challenges in effectively utilizing technological devices to enhance student cognitive engagement and academic achievement.

While students today are often referred to as "digital natives" due to their familiarity with technology, empirical evidence emphasizes the importance of shifting the focus to understanding them as "digital learners" (Wallace-Spurgin, 2020). This highlights the

growing use of digital technology and the necessity of catering to these digital learners' unique needs and learning styles.

In Wang's study conducted in 2018, the focus lies on developing a comprehensive instrument that can assess the impact of technology-mediated learning (TML) on the learning process. The research also aims to establish theoretical constructs and operational definitions for this instrument. The researchers emphasize the importance of conducting an empirical study to validate the effectiveness of the multi-scale instrument. Fortunately, TML has been recognized as a valuable tool in educational settings. However, assessing the efficacy of TML remains a critical challenge in both research and practice. Therefore, further investigations are required to measure the impact of TML on the learning process accurately. According to Wang (2018), TML refers to an educational environment where information technology facilitates learners' interactions with learning materials, peers, and instructors.

According to Lai (2022), research indicates a need for more comprehensive instruments to evaluate technology use in education. When assessing learning facilitated by technology, the evaluation process becomes complex and subject to controversy (Muller & Wulf, 2020, as cited in Lai, 2022). Researchers should focus on evaluating learning outcomes rather than solely assessing the technology. The study identified methodological limitations in measuring the effectiveness of technology use and evaluating learning outcomes. It also highlighted the absence of a standardized approach for evaluating technology-enhanced learning, and the existing research on high-quality, evidence-based evaluation methods still needs improvement (Lai, 2022).

Benefits and Challenges

In today's rapidly advancing digital era, technology has become an integral part of our lives, permeating various domains, including education. This section of the literature review delves into the exploration of benefits and challenges related to the implementation of technology at the elementary level. Educators, administrators, and policymakers can gain valuable insights from this section as they navigate the intricate landscape of educational technology integration. The initial focus is on examining the positive influences of technology implementation on student learning. Extensive research consistently reveals the positive effects of integrating technology into classrooms, showcasing enhanced student engagement and motivation, particularly through peer-led discussions.

The evidence robustly supports the idea that the integration of technology yields advantageous outcomes for students. Nonetheless, determining the precise role that technology should play in students' learning and education continues to spark ongoing debates within the educational community. Thus, this section aims to shed light on the advantages and challenges associated with incorporating technology into educational practices, facilitating a comprehensive understanding of its implications in the elementary school context. the curriculum can provide practical strategies for successful utilization in schools.

According to Costley (2014), incorporating technology in the classroom can positively influence student learning. Multiple studies have consistently demonstrated the positive effects of technology integration on student learning outcomes. Additionally, research has revealed favorable outcomes regarding student engagement and motivation through peer-led discussions. The evidence consistently supports the notion that integrating technology into education yields beneficial results for students. Blazer, 2008 will discuss

the role that technology plays in student achievement. Next the literature will look at the role technology plays in education and how to use technology for learning.

In Blazer's, 2008 work, educators are prompted to consider the role that technology integration should play in students' learning and education. Within the educational community, there is an ongoing debate regarding the positive effects and outcomes associated with technology integration. Blazer (2008) explores the advantages and challenges of incorporating technology into the curriculum and aims to provide practical strategies that contribute to its successful utilization in schools. It is widely acknowledged among researchers that there is no singular "right" type of technology or universally prescribed method for its use (Blazer, 2008). Blazer, 2008 continues to discuss the benefits of effective technology integration for students.

The implementation of technology in classrooms can greatly benefit teachers by enabling them to customize instructional materials and assessments according to their student's individual learning needs. Technology offers a wealth of authentic resources that can aid teachers in creating and delivering engaging lesson plans. However, challenges arise when some educators indiscriminately endorse technology without considering the quality of teaching and learning experiences it produces (Blazer, 2008). Additionally, logistical, and technical issues can lead to the termination of technology programs in certain school districts. For technology to be most effective, it should be utilized to access information and enable students to communicate their findings using visual aids such as pictures or graphs. Whether students should use technology individually or collaboratively sparks varying beliefs. Despite this, students benefit from the social aspects of collaboration when utilizing technology to demonstrate their learning. Ultimately, the question lingers as to whether

introducing technology into the classroom positively impacts teaching and learning (Blazer, 2008). Next, we will look at future trends and shifts of technology in schools.

Dube (2021) conducts a comprehensive analysis of technology trends in K-12 education from 2011 to 2021. Technology is rapidly evolving and undergoing constant change; however, there needs to be more attention given to the outcomes and impacts of these changes. This study aims to provide an overview of the shifting trends in educational technology and its implementation. The findings reveal a clear trajectory toward adopting mobile and analytical technologies over the past decade. Notably, the findings from 2011 to 2021 indicate that mobile technology has emerged as the most effective form of educational technology (Dube, 2021).

In contrast, Yilmaz (2020) examines critical thinking, multidimensional 21st-century skills, and the associated shift in academic achievement. The participants in this study were prospective teachers who compared instruction with and without technology integration. The research employed qualitative data collection methods, including semi-structured interviews, observations, and field notes. The results strongly support the notion that the gradual integration of technology into the educational process brings about positive changes. Yilmaz's study emphasizes the benefits of incorporating technology into instruction and its impact on fostering critical thinking skills and multidimensional competencies (2020). We next look at technology effectiveness and how to use technology effectively in the classroom.

Chauhan (2017) undertakes an objective study to explore how technology can be integrated to enhance the learning effectiveness of elementary students. The study results indicate that technology has a moderate impact on the learning effectiveness of elementary

students. This research analyzes factors such as the subject domain, application type, intervention duration, and learning environment. The findings suggest that various e-learning methods employed in elementary schools offer more enduring outcomes compared to traditional learning approaches. Successful classroom technology implementation positively influences instructional practices and student learning. The literature then discusses the integration of iPads in education and parent perception.

In a separate study, Eppard (2022) investigates the perceptions of parents and students regarding the effectiveness of iPad integration in the classroom. The research involves administering questionnaires to students and parents, focusing on how iPads can support learning. The results reveal that 80% of students reported a better understanding new concepts through iPad usage. Furthermore, the integration of iPads in math instruction has been found to enhance student engagement levels and attention.

Unser (2017) argues that the incorporation of technology in educational settings yields positive outcomes and enriches student success and experiences. Students actively engage, collaborate, and construct knowledge within these learning environments. The study emphasizes the importance of teachers' technological expertise, as their knowledge and proficiency significantly impact the successful implementation of technology in the classroom. The findings underscore the crucial role of integrating technology into the educational process in enhancing students' academic achievements.

In related research, Christopoulos (2020) examines the benefits and limitations of educational technology, specifically in elementary school mathematics. The research compares the skills and competencies developed through the intervention and includes data on successful student outcomes. Ultimately, the study highlights the educational potential of

curriculum-driven digital learning tools, shedding light on their capacity to support and enhance mathematics learning at the elementary school level.

Bower (2017) explores the integration of technology-enhanced learning research and practices, focusing on educators, pre-service teachers, post-graduate students, and researchers. The study investigates various design options available for technology-enhanced learning. The findings underscore the potential of leveraging different technologies in contemporary learning practices, highlighting possibilities for exploration and implementation.

In a related context, Wilson (2015) expresses concerns about providing opportunities for students to grasp various concepts within science education. Teachers face the challenge of implementing substantial changes to support teacher learning and development in education. The need for equitable access to science education and science technologies for all students is emphasized. Establishing professional development programs for teachers to create an inclusive classroom environment that incorporates technology for learning is crucial. These programs will equip educators with the necessary skills and knowledge to effectively integrate technology into their instructional practices.

Chiu's recent research (2023) focuses on the emerging and novel applications of artificial intelligence (AI) in education. The systematic review aims to gain insights into the opportunities and challenges associated with AI in education. The study analyzes literature published from 2012 to 2021 using matrix coding and content analysis approaches. The findings reveal the current areas of focus in AI in education research, including AI technologies' roles in key educational domains, facilitated learning outcomes, and

significant challenges. Additionally, the review offers suggestions for future directions in AI in education research (Chiu, 2023).

In 2023, Ricci Raquel Cordeiro conducted a study on the effects of technology on early childhood, highlighting both positive and negative aspects. While previous sources predominantly highlighted the detrimental impacts, Cordeiro's research shed light on potential benefits as well. Excessive internet usage was associated with intellectual deficits and mental health concerns, particularly anxiety symptoms when children were separated from their mobile devices. To mitigate these risks, the study recommended parents to enforce limits on screen time and exercise control over the content their children are exposed to (Cordeiro, 2023).

Vaughan (2015) researched the impact of iPads on teacher educator practice and examined the efficacy of iPads for professional development among teachers. The study emphasized the importance of addressing infrastructure barriers that may hinder the implementation of iPads in schools. It also highlighted the disparities between students' expectations of faculty technology use. The research underscored the necessity for educational institutions to develop and implement a robust academic vision rooted in technology integration. To ensure successful technology implementation, teachers require supportive systems to enhance their understanding of future technology use and address the specific needs of faculty within schools. Furthermore, future research should prioritize pedagogical innovation to create student-centered learning environments (Vaughan, 2015).
Menon (2022) conducted a study during the COVID-19 pandemic, focusing on exploring the uses and gratifications associated with educational apps. The research identified seven key gratifications influencing students' intention to use educational apps, including

academic assistance, convenience, entertainment, social influence, novelty, engagement, and activity.

Attention and Technology

Attention plays a vital role in our effective interaction with technology, influencing how we utilize it. It is a cognitive function that allows us to focus, filter out distractions, and maintain concentration. Technology can enhance attention by providing tools and features that help students manage distractions and cultivate a productive work ethic. However, it is important to recognize that attention and technology can both support and hinder student learning.

According to Francis (2017), the widespread integration of technology into our daily lives has made students constantly connected to a vast amount of information. Francis advocates for the use of technology in education, highlighting its potential to improve students' academic performance. Implementing technology in educational settings has been found to be beneficial in helping students recognize the intrinsic value of what they learn, subsequently increasing their interest and motivation (Chapter 1, James, 2017). To effectively support students' attention and learning, technology should be employed in ways that accommodate diverse learning approaches. By incorporating appropriate technology, students can be motivated across various disciplines, such as mathematics, social studies, and literacy (Francis, 2017).

In an article authored by Natalia Kurcirkova, an affiliate of the Education and Language Studies faculty at the Open University in Milton Keynes, UK, a quantitative research approach is adopted to investigate the use of iPads in early childhood education. The article addresses the gap related to technological determinism and the digital/non-

digital binary. One of the primary studies discussed in the article involves observational studies examining how teachers navigate the optimal use of technology in the classroom. The researchers aim to utilize robust methodologies such as randomized controlled trials or design-based research to critically assess whether iPads effectively enhance students' learning outcomes.

The research cited in this article draws upon design-based research and randomized controlled trials to justify interventions and pedagogical applications. The author concludes that the research conducted thus far has provided valuable insights into how children interact with iPads. The initial wave of iPad research identifies potential educational benefits, while subsequent research utilizing design-based research and randomized controlled trials uncovers misconceptions about the role of technology in early childhood education. The article emphasizes the need for future research to critically evaluate the effectiveness of iPad integration as an innovative pedagogical support in the classroom. Given the widespread use of iPads as educational tools, this study holds significant importance in understanding the current state of knowledge in this field.

Carstens (2012) addresses the impact of technology on student learning, specifically focusing on how it influences the educational process and student engagement. The study employs a methodology involving teacher surveys and data collection, incorporating a mix of open-ended questions, multiple-choice questions, and a Likert scale. By synthesizing the trends observed in the collected data, the researchers gain insights into educators' perspectives on technology use in education. The findings prove instrumental in deepening the authors' understanding of how technology integration in the classroom can either facilitate or hinder student learning.

The study's data reveals that participants consider technology as a valuable tool for student engagement and enhanced learning. Additionally, participants express that utilizing technology in the classroom fosters effective student communication and collaboration. The findings highlight both the positive and negative aspects of technology use in educational settings. Notably, the data indicates that 62.07% of the participants are elementary school teachers, enhancing the research's validity and relevance to the field.

The study participants willingly volunteered to participate in the survey, providing valuable insights into the various ways teachers employ technology in the classroom. This source can be considered credible and reliable. The research encompasses a comprehensive examination, including a literature review, findings on fine motor skills and motivation, exploration of expanded learning opportunities, detailed methodology, results, and the presentation of data through a comparative bar graph. Published in the Turkish Online Journal of Educational Technology, this article serves as a supportive resource for teachers and schools seeking guidance on utilizing technology for effective teaching and learning. Notably, the article has undergone a rigorous peer-review process and is openly accessible, targeting researchers and policymakers involved in educational technology.

Ping's (2016) study focuses on technology integration in elementary education and the teaching practices of student teachers. The research examines student teachers' observations and data sets, exploring how they use technology to enhance visual attention, engagement, and interaction in the classroom. The participants, who are student teachers, consciously choose to integrate technology into their teaching practices to address essential aspects such as student engagement, time management, motivation, and meeting individual student needs. The empirical evidence from the study reveals that pre-service teachers, in

this case, the student teachers, still have room for growth in effectively integrating technology into their teaching. As a result, it becomes crucial for teacher preparation programs to critically evaluate how pre-service teachers apply technology as an instructional practice and provide the necessary support to enhance their technological integration skills.

Lodge's (2019) research delves into the significance of attention in learning in the digital age. One of the critical challenges associated with technology implementation is the potential negative impact on attention, as it has been identified as a cognitive function affected using digital technologies for learning. The study examines the current cognitive neuroscience understanding in educational settings to gain a better understanding of this claim. It explores the relationship between technology and attention using a systematic approach, considering various levels of analysis.

Lawrence (2022) investigates the effects of increased technology usage on elementary students. The study explores how technology influences student development, social skills, and learning outcomes. In California, computer science standards emphasize the early introduction of technology skills, with students expected to acquire computer literacy and basic programming abilities by the end of second grade. With the growing prevalence of technology and online learning, it becomes imperative for teachers to evaluate the impact of tablets, iPads, and computers on their students' learning experiences. Teachers and elementary schools should carefully consider factors such as the use of technology-recommended screen time guidelines and the effects on learning outcomes to ensure optimal educational outcomes for students.

In this section, an examination was conducted on research related to technology implementation, focusing on three major themes: measuring learning, benefits and challenges, and attention and technology. These themes have significant implications for integrating technology at the elementary level. The following section will delve into the role of technology in teaching and learning at my job site. The action plan will encompass these three themes and provide recommendations for future research.

The Action Plan

In this literature review I am examining technology implementation in elementary education. I found three themes: measuring learning, attention and technology, and benefits and challenges.

My site, Sunnyvile Elementary(pseudonym) is a public institution catering to kindergarten to 5th-grade students. The school has an enrollment of 365 students, and it places importance on academic achievement. Regarding math proficiency, 42% of the students at the school have attained or surpassed the proficient level. Similarly, 52% of the students have achieved or exceeded proficiency in reading. With a minority student enrollment of 36%, the school boasts a diverse student body. The student-teacher ratio stands at 15 to facilitate effective instruction, ensuring reasonably sized classes. Approximately 40% of the students are classified as economically disadvantaged, indicating that a significant proportion of the student population may confront socioeconomic hurdles.

Measuring Learning

Table 1 summarizes literature findings on measuring learning and technology implementation in elementary education. The research underscores the significance of assessing student engagement by gathering prompt feedback on learning progress. In my workplace, there

has been a substantial increase in technology usage for learning and progress assessment. iPads have become essential tools for students, particularly in completing assessments like I-ready math and reading tests. These assessments play a pivotal role in determining students' math and reading placements for the upcoming school year, offering valuable insights into their academic growth. Policymakers in elementary education place a high value on technology integration and measuring learning outcomes, focusing on academic achievement, equity, professional development, and data privacy. Their priorities include tracking progress, fostering engagement, addressing barriers, utilizing practical pedagogical approaches, facilitating assessment, and ensuring equitable access to technology. These efforts aim to enhance technology integration and elevate educational experiences in elementary schools.

Table 1

Measuring Learning

Key findings from the literature review	Practice (at my job site)	Recommendations
According to the literature, assessing student engagement in the classroom involves teachers gathering prompt feedback from students regarding their learning progress (Solé-Beteta, 2012).	In my workplace, there is a notable surge in the utilization of technology for learning purposes and the assessment of student progress. Students now frequently engage with their iPads to complete various assessments. For instance, they take I-ready math and reading tests, which provide valuable insights to inform their math and reading placements for the upcoming school year. At my site, teachers give immediate feedback to students and written feedback. I use formative assessment while I'm	TEACHERS HSOULD USE THIS… Policymakers acknowledge the significance of technology integration and measuring learning outcomes in elementary education. They emphasize several critical perspectives and considerations, including assessing learning outcomes, equity and access considerations, professional development, and data privacy. Policymakers highlight the importance of tracking learning outcomes and academic achievement, implementing engagement and motivation strategies, assessing barriers to technology adoption and utilization, employing practical pedagogical

	teaching to check for understanding. Teachers receive feedback from student exit tickets, or their tests scores which show the areas they need support on.	approaches and instructional strategies, facilitating assessment and feedback, and ensuring equity and access to technology for all students. These considerations align with the policymakers' commitment to promoting effective technology integration and enhancing educational experiences in elementary schools.
The literature on student engagement said that "in lessons where students were less engaged, teachers found higher levels of chaotic teaching behaviors" (Cents-Boonstra, 2019). The literature also found that learning with technology provides a "viable tool for differentiated learning and instant feedback" (Eppard, 2022).	At my site, teachers make learning fun and engaging so that students stay motived and on task throughout the day and when using technology. When students are engaged in their learning, we see more participation and motivation to learn. Guiding students through their work and how to use their devices helps to inform students and keep them engaged.	Schools need to do a better job at engaging their students and keeping them motivated. Recommendations for teaching with technology and engaging students say to use interactive multimedia, foster collaboration and provide personalized learning with adaptive technology. It is recommended that teachers have students work collaboratively and independent and use technology learning tools to assess student learning and motivation. It is important for teachers to hold students accountable for their learning while interacting with their learning devices.
The literature suggests there is "no single too for a comprehensive evaluation of technology use in education" (Lai, 2022). This means that students have different learning styles and different levels of knowledge on technology. Researchers suggest that there is a "an absence of comprehensive mechanisms to evaluate technology-enhanced learning" (Lai, 2022).	At my site teachers use different methods to measure learning such as formative and summative assessments. We also assess students reading and their phonics knowledge. Students are also assessed through observation of their interactions and collaboration with their peers. Students seem to be motivated to participate when technology is used. Students can interact with technology and share their	Policymakers acknowledge the significance of technology integration and measuring learning outcomes in elementary education. They emphasize several critical perspectives and considerations, including assessing learning outcomes, equity and access considerations, professional development, and data privacy. Policymakers highlight the importance of tracking learning outcomes and academic achievement, implementing engagement and motivation strategies, assessing barriers to technology adoption and utilization,

Another key finding from the literature argues that teachers must “factor a student’s motivation to learn and the effects that technology has on education” (Francis, 2017).	thoughts with one another on class message boards.	employing practical pedagogical approaches and instructional strategies, facilitating assessment and feedback, and ensuring equity and access to technology for all students. These considerations align with the policymakers' commitment to promoting effective technology integration and enhancing educational experiences in elementary schools. Schools should continue to support students in their learning by promoting collaborative engagement between peers and using technology as a learning tool in support of peer engagement. Teacher preparation programs need to address how teachers can use multiple methods on technology implementation and learn how to adjust to their student’s needs.

Benefits and Challenges

The literature acknowledges the barriers and benefits of technology integration in education. Educators should avoid indiscriminately adopting technology, assuming it guarantees effective teaching and learning (Blazer, 2008). However, technology integration can enhance student experiences and contribute to their success (Unser, 2017). Implementing technology in classrooms presents challenges for teachers, requiring changes in support systems, education, and professional development (Wilson, 2015).

In our workplace, we employ strategies to overcome technology integration barriers. We provide regular tech support check-ins and one-on-one assistance to students with technical issues. Teachers benefit from an intranet system that enhances information access and collaboration among staff. We prioritize equitable access to technology for all students and

involve families and the community to support this goal. By addressing barriers and fostering a supportive environment, we aim to maximize the benefits of technology integration. Recommendations for effective implementation include a comprehensive approach to address barriers, continuous professional development for teachers, proactive efforts to address equity and access, and regular monitoring and evaluation of technology's impact on student achievement.

Table 2

Benefits and challenges

Key findings from literature review	Practice	Recommendations NEEDS TI ALIGN WITH FIRST COLLUM
According to the literature, one identified barrier to technology integration is the tendency of some educators to indiscriminately embrace technology if its mere use automatically leads to high-quality teaching and learning experiences (Blazer, 2008). Conversely, the literature also highlights the benefits of technology integration. For instance, Unser (2017) asserts that incorporating technology in educational settings can positively impact student experiences and contribute to their success. However, teachers encounter challenges in implementing technology, such as the need for substantial changes to current teacher support systems, education, and	In my workplace, we employ various strategies to overcome barriers to technology integration. This includes regular tech support check-ins and one-on-one assistance to students with technological issues. Teachers benefit from a newly implemented intranet system that enhances their access to information and facilitates collaboration among staff members. Moreover, our site prioritizes equitable access to technology for all students and actively involves families and the community in these efforts. By addressing these barriers and fostering a supportive environment, we strive to maximize the benefits of technology integration in our setting.	By adopting the suggested recommendations, schools can effectively overcome obstacles hindering technology integration and establish an environment that optimizes the advantages of technology for student learning and achievement. • Employ a comprehensive and systematic approach to address barriers associated with technology implementation. • Offer teachers continuous professional development opportunities, ensuring technology usage alignment with learning objectives. • Proactively address disparities in equity and access to technology resources. • Regularly monitor and evaluate technology implementation, assessing its impact on student

professional development (Wilson, 2015). Another key finding includes the need for teacher preparation programs to teach technology integration and use in schools. Many teachers are new to certain aspects of technology. Teacher training on technology will support them in effective technology implementation.	Teachers are having to adhere their lessons to meet the needs of their students while also incorporating technology use that is easy and accessible for all students. Teachers are often taking much of their own time to learn these new applications and how to effectively incorporate them into instruction.	achievement and academic outcomes. It is recommended that new and experienced teachers get the training and support they need to effectively implement the use of technology for their students. Research on the impact of technology use on teachers needs to be further studied so that districts can best support their teachers in the implementation of technology. Training courses and professional development for teachers needs to address new all new technologies and applications.

Attention and Technology

Research consistently highlights the positive effects of technology implementation on students' recognition of the value of their learning, leading to increased interest and motivation (James, 2017). However, challenges arise in integrating technology, particularly concerning attention as a cognitive function, which can be negatively impacted by digital learning tools (Lodge, 2019). Each student is equipped with an iPad as an assessment tool and a valuable learning resource at my workplace. We emphasize the importance of limiting screen time for students to address attention and technology concerns. We also strive to engage them through hands-on learning experiences and purposeful utilization of educational applications on their devices. This approach promotes a balanced use of technology, ensuring active student engagement in their education. Policymakers advocate for key recommendations, including prioritizing digital well-being education, implementing age restrictions and parental controls, and developing ethical technologies. They also stress the significance of promoting digital literacy skills. In line with existing research, experts recommend minimizing distractions in educational settings, fostering attention and mindfulness through training, and adopting personalized

instruction to optimize learning outcomes. By implementing these recommendations, policymakers and educators can work together to create a technology-enhanced environment that supports well-being, responsible usage, and effective learning practices.

Table 3

Attention and Technology

Key findings	Practice	Recommendation
Research consistently indicates that technology implementation has proven beneficial in fostering students' recognition of the intrinsic value of their learning, thereby enhancing their interest and motivation (James, 2017). However, the literature also underscores challenges associated with technology integration, particularly regarding attention as a cognitive function that may be negatively affected by using digital technologies for learning (Lodge, 2019).	Each student has an iPad, an assessment tool, and a valuable learning resource at my workplace. We emphasize the importance of limiting screen time for students to address attention and technology concerns. Additionally, we strive to engage students through hands-on learning experiences and purposeful utilization of learning applications on their devices. By adopting these practices, we promote a balanced approach that maximizes the benefits of technology while ensuring students remain actively engaged in their education.	Policymakers advocate for key recommendations, including prioritizing digital well-being education, implementing age restrictions and parental controls, and developing ethical technologies. Furthermore, policymakers emphasize the importance of promoting digital literacy skills among individuals. In alignment with the literature, researchers recommend minimizing distractions within educational settings, cultivating attention and mindfulness through training, and adopting individualized instruction approaches to optimize learning outcomes. By implementing these recommendations, policymakers and educators can work towards creating a technology-enhanced environment that fosters well-being, responsible use, and effective learning practices.

In this section I applied recommendations to the key findings throughout the literature and discussed the practices used at my site. I will now return to my rationale questions, answer them, and provide recommendations for future research on technology implementation in elementary education.

Discussion

In the literature review I have examined the research on technology implementation at the elementary level. The three themes I've identified from the literature are measuring learning, benefits and challenges and attention and technology. I also applied those themes to my research site at Sunnyville Elementary. Sunnyville Elementary is a public k-5 school and is situated in a large suburban setting. In this section I will answer the questions posed in my rationale. My questions are how can the integration of technology enhance the learning experience of elementary school students? What potential negative impacts are there for technology integration? Lastly, how can the use of technology in elementary education help to bridge the digital divide and promote equity in education? In this section I will also discuss implications for research, and limitations of this projects.

Discussion of Findings

In the rationale I asked 3 questions: how can the integration of technology enhance the learning experience of elementary school students? What potential negative impacts are there for technology implementation? How can the use of technology in elementary education help to bridge the digital divide and promote equity in education? In this section, I will address these inquiries by drawing upon my research findings and teaching expertise. Subsequently, I will evaluate the most effective approaches for integrating technology at the elementary level.

Technology Enhancing Learning Experience

My first question was how can the integration of technology enhance the learning experience of elementary school students? In my examination of how the integration of technology can enhance the learning of elementary school students, I found that the students learning experience was greatly improved when using technology in the classroom. My research found that using technology motivates and engages students in their learning. I've observed a notable increase in student's motivation to learn when they are allowed to incorporate technology into their educational experiences. At my job site, a personal example of this is the widespread popularity of Kahoot, a game that elementary students, including my own, thoroughly enjoy. The excitement that arises from actively participating with their devices and witnessing the game unfold on the projector screen adds a fun element to their learning. Students foster a sense of personalization by crafting amusing aliases and adopting diverse characters to express themselves. The game's competitive nature captivates and motivates them to play persistently, and they are eager to discover what awaits them in the next challenge.

When students receive "coins" representing points or scores on a learning application, they experience a gratifying sense of independence and accomplishment. This gamified element within the app grabs their attention and enhances their focus, similar to the captivating nature of video games. During my teaching experience, I have observed this phenomenon when students engage in educational game-like competitions facilitated by interactive apps. By using such apps, students connect and share a common interest with their peers and have the opportunity to collaborate and communicate regardless of their physical location within the classroom. Additionally, the immediate feedback provided by the commonly used apps, based on students'

scores or difficulty level, contributes to their sense of reward and satisfaction when they answer correctly.

The literature argues both that technology can enhance student experience and can be a distraction in the classroom. Lodge's work on attention and technology comments on the influence of technology on learning, "there is a difficulty in determining how biological processes are influencing and being influenced by technologies" (Lodge, 2019). In the modern classroom some students may be more influenced by the technology which can be distracting or diminish the learning experience for students. Others may be part of the influence for how we develop and use technology as a learning aid, leading to an enhanced sense of comprehension and engagement for the students. These contrasting experiences can occur in the same classroom as well, however when more students are feeling the engagement in a positive way, they can lead the classroom to better overall learning. In my classroom, I have seen students who are using the technology in a positive way have more influence on how I use technology in the future, as well as influencing students who tend to get distracted or deterred by technology use to engage more positively and even better follow the curriculum. My readings also mentioned how technology can hinder a student's learning experience, "such media multitasking has been implicated in poorer learning in the classroom" (Lodge, 2019). In contrast, the literature also found that technology can enhance learning experiences due to "an interactive learning network (ILN) is effective in improving the classroom learning experience" (Unser, 2017). An ILN "incorporates both behaviorist and constructivist theories and is the idea that it's the student's responsibility to complete work prior to class instruction which will then cause students to make better connections to the content" (Unser, 2017). I think both Lodge and Unser explain why technology can have positive or negative impacts.

In addressing the initial inquiry of the rationale - how can integrating technology improve the learning experience for elementary school students? - it is evident that integrating technology can significantly enhance the learning process for these students. Motivation, engagement (Francis, 2017), and student achievement (Francis, 2017), outcomes are notably enhanced by incorporating technology (Costley, 2014). Teachers have reported witnessing an upsurge in students' motivation levels, with technology as a valuable learning tool that engages them in the classroom.

Potential Negative Impacts

My second question is what are the potential negative impacts are there for technology integration? This section explores the potential negative impacts of implementing technology, as addressed in the research. Christopoulos (2020) investigates the limitations of educational technology, particularly in the context of elementary schools, highlighting the skills and competencies developed through its intervention and presenting data on student outcomes. Moreover, I have observed adverse effects of technology use at my school that can impede student learning, including time constraints and technical difficulties. In our setting, we assess student progress through formative and summative evaluations. Furthermore, the research suggests that students who effectively regulate their learning needs and carefully plan their tasks are more successful. However, this level of self-regulation is only sometimes observed among students (Christopoulos, 2020). I have witnessed this phenomenon at my school, especially among lower elementary students who struggle to remain focused and self-monitor their activities independently using devices such as iPads, laptops, or tablets.

From my personal experience, certain negative aspects are associated with implementing technology in education. One major issue is the occurrence of technical difficulties, which can

lead to various problems, including the consumption of valuable learning time in attempts to reboot and troubleshoot technology-related issues such as low battery levels and complex user interfaces. Another obstacle I have encountered is the time constraint regarding technology implementation. Delays caused by device updates and a sluggish internet connection, mainly when the Wi-Fi signal is weak, can severely impede students' ability to utilize and learn with technology effectively.

Implementing technology can have potentially adverse consequences, particularly when students encounter difficulties or make mistakes. Students may become overwhelmed and frustrated when faced with challenges or experiencing user-related issues. This frustration can lead to a loss of motivation that they initially had when they began using the device. I have witnessed instances where students express their frustration by forcefully placing their devices, such as iPads, on their desks, causing distractions for other students. Furthermore, such behavior can result in students losing their privileges to use technology in the classroom, ultimately depriving them of valuable learning experiences.

Returning to the second question of the rationale - what are the most typical adverse effects of technology integration according to researchers? One common finding was student motivation, “motivating students in the classroom can be difficult and is like giving each student their own smartboard” (Carstens, 2021).

Additionally, in my personal experience, I have witnessed the frustration students face when encountering technological difficulties and the challenge of monitoring student learning solely through an iPad, which limits opportunities for observing student interactions and discussions.

Bridging the Digital Divide and Promoting Equity

The next research question is how can the use of technology in elementary education help to bridge the digital divide and promote equity in education? This section explores how technology utilization in elementary education can contribute to bridging the digital divide and fostering equity in the educational landscape. According to Vaughan (2015), it is crucial for future research to prioritize pedagogical innovation, aiming to establish student-centered learning environments. However, observing my school, I have identified a need for promoting equity regarding technology integration. Unfortunately, this issue arises due to a need for prioritization within the school system and the overwhelming focus on achieving high test scores and meeting academic standards within our large district. As a result, the school tends to overlook the potential impact of seemingly minor details that can significantly contribute to equitable technology implementation. Additionally, the school's emphasis lies primarily on identifying practical applications for learning rather than considering students' individual learning styles.

Technology has the potential to engage students more actively in the learning process, allowing them to learn at their own pace and in their preferred style (Francis, 2017).

Technology can automate routine tasks, freeing teachers to focus on meaningful activities such as teaching, grading, and providing feedback. Technology can be expensive, and many schools and students may need access to the necessary equipment or resources. The digital divide refers to the gap between those with access to technology and those without access. This can lead to unequal educational opportunities for students. Technical problems like network connectivity, hardware failures, and software glitches can disrupt the learning process and frustrate students and teachers. Using technology in education can raise concerns about data security and student privacy. Integrating technology in education requires teachers to have the necessary skills and training to effectively use and implement technology in the classroom.

At my school, we prioritize the accessibility of technology by fostering learning environments that are safe, culturally respectful, and welcoming. Students are granted equal access to classes, services, and their devices (iPad) through a 1:1 approach. Through this 1:1 device implementation, we aim to cultivate digital citizenship among our students. Moreover, we strive to ensure that learning with technology is accessible to individuals with disabilities while maintaining user-friendliness for all. I've witnessed this commitment at my site, where student iPads feature specialized applications tailored to their unique learning styles or individualized education plans (IEPs), providing supportive tools and accessibility options. Additionally, students receive one-on-one support within the classroom to optimize their technology experience.

Technology Impacting Students' Critical Thinking

An additional analysis is how does technology impact a student's critical thinking and problem solving? Yilmaz (2020) explores the relationship between technology and student critical thinking, offering an additional analysis on the subject. Given the integration of technology into our daily lives, it becomes imperative to understand how it influences critical thinking within the classroom. Yilmaz argues that technology is reshaping the learning process and fostering the development of innovative skills, particularly in critical thinking and problem-solving. Costley (2014) further supports this notion, suggesting that technology can be a valuable tool for creating meaningful projects that actively engage students in critical thinking and problem-solving endeavors.

I have personally witnessed my students applying their critical thinking abilities to tackle reading comprehension questions, solve math equations, and tackle word problems. The applications they utilize offer multiple-choice options, prompting them to engage in

critical thinking by utilizing the process of elimination to select the correct answers on their devices. I actively assess their critical thinking skills as I teach and circulate around the room during work time. When my students engage in critical thinking, they delve into the underlying reasons behind phenomena, compare and contrast different ideas and perspectives, and are capable of providing explanations for various occurrences. Moreover, they can transfer the knowledge and skills acquired through their learning applications or assessments to non-technological learning experiences.

Implications for Schools

The literature found common themes surrounding implications for schools such as offering enhanced learning opportunities for students. Another is personalized learning which will provide to student's specific needs. One finding that repeated itself the most throughout this research was expanding access to education and technology and leveraging technology so that schools can serve their students and families. Another common implication for schools was increased teacher technology trainings and professional development. Educators need effective training to learn the skills necessary to use technology and integrate it into their teaching practices. Teachers also need support in how they adapt instructional strategies to harness the benefits of technology. There is a need for "faculty members to integrate innovative technology into their teaching" (Vaughan, 2015). Another implication for schools is that "high effectiveness of informal learning environments suggests that school authority should lay more focus on holding a number of informal learning activities" (Chauhan, 2017). This means that the school environment can impact a student's motivation to learn and engage with technology. Research suggests that

if technology is “interwoven comprehensively into pedagogy, it can act as a powerful tool for effective learning of elementary students” (Elsevier, 2016).

Implications for Future Research

Future research highlights the importance of providing teachers with comprehensive professional development courses and opportunities to enhance their knowledge (Unser, 2017). There is a need for researchers and theorists to bridge the gap between technological advancements and our understanding of attention processes in the brain, as there exists a disparity between foundational research and real-world complexities (Lodge, 2019). A systematic approach is essential to bring researchers and practitioners together, facilitating a better understanding of how technology impacts our cognitive processes (Lodge, 2019).

What I did not find from the research were the resources are available for teachers on incorporating and implementing technology in instruction and assessments. I would have also liked to have found more data on students’ feelings regarding using technology in the classroom and how they compare learning with and without the integration of technology or use of technology. Another thing that missed from the literature was how districts and schools would implement new teacher and personal training for technology implementation. Many studies said there is a need for “more” professional development and not how schools are going to start creating those programs for its teachers and staff. Another finding missing from the research is how students feel empowered to control their own learning using technology and how students are driven to want to make connections with their peers when they are all individually using technology.

Also missing from the research is information on the teacher's perspective on effective instructional technology. Much of the research is on student achievement and

student impact. There is little research on teachers' effectiveness in technology implementation. Researchers must dive into how teachers use technology interchangeably in the classroom and for their student's learning. Research must be done on how teachers use and integrate technology into their students' learning. Students may be getting different types of instruction due to teacher types and how specific districts or schools use technology and learning.

Limitations

The research on attention and technology implementation in elementary education faces several notable limitations. First and foremost, a prevalent limitation concerns the issue of teacher training and support. The successful integration of technology in the classroom is contingent upon teachers’ proficiency, knowledge, and access to adequate support. Regrettably, a need for more comprehensive research delves into the specific training and support requirements necessary for teachers to utilize technology in their instructional practices effectively.

Furthermore, the measurement of attention presents a significant challenge. There is yet to be a universally accepted standard for measuring attention in technology implementation. This lack of consensus leads to variations in measurement tools used across different studies, making comparing and synthesizing findings arduous. Consequently, it becomes difficult to establish a cohesive body of knowledge on the relationship between attention and technology in educational settings.

These limitations underscore the need for further research that addresses teachers’ training and support needs in technology implementation. Additionally, efforts should be directed toward developing standardized and validated measures of attention to facilitate

better comparability and understanding across different studies. By addressing these limitations, researchers can advance the understanding of attention and technology implementation, ultimately contributing to more effective and evidence-based educational practices.

The limitations for the literature review also include the year ranges of the research, the evolution of its search parameters, inclusion, and exclusion as well as what impacted my ability to search for findings. The dates of the research from the literature review span from 2011 to 2023. This is current and relevant research and findings based on current observations in different parts of the world, which still had common themes surrounding technology implementation. The inclusion of the research meant that all stakeholder's had to have equal access to technology in the classroom and or at home if that is where research took place. The exclusion of technology implementation research is limited participation and repeating the studies in different scenarios. Some of the studies only adhered to the school or site in which the research took place, which limits the wide range of apps used or technologies used world-wine in education.

Conclusion

In summary, implementing technology in elementary education holds promise for positively impacting student learning outcomes. However, it is crucial to approach this implementation with careful thought and consideration of potential challenges. To ensure successful integration, educators must adhere to best practices, offer continuous support, and skillfully incorporate technology into the classroom environment. Throughout this paper, an exploration of existing research on technology integration has been undertaken to identify and highlight the best practices necessary for effective implementation. By

following these guidelines, educators can create an enriching learning experience that maximizes the potential of technology in elementary education.

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