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Leveraging Technology To Support The Goals Of Dual Language Bilingual Education: An Explanatory Sequential Mixed Methods Study

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LEVERAGING TECHNOLOGY TO SUPPORT THE GOALS OF DUAL LANGUAGE BILINGUAL EDUCATION: AN EXPLANATORY SEQUENTIAL MIXED METHODS STUDY

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Dedication

I dedicate this dissertation to all who supported me during my doctoral journey. To my husband, Otayorjon Muhammadali, for encouraging me to follow my dreams and being patient while I navigated the demands of my work and my studies. To my children, Alina and Amir, who were understanding most of the time when they wanted to play with me, but I couldn't because I had homework to do. I hope to be a good role model for them. To my parents who showed me the value of education and taught me that anything is possible with hard work and dedication. A mis padres por acompañarme y ayudarme. A mis hermanos por creer en mí y alentarme. To my wonderful friends, Cristina Celis and Leanne Navarro, who supported me during my teaching career and my doctoral journey.

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Abstract

This explanatory sequential mixed methods study explored how and why dual language (DL) teachers used technology and the extent to which their use of technology supported the goals of DL of bilingualism, biliteracy, academic achievement, and sociocultural competence. The study was guided by Mishra and Koehler's (2006) technological pedagogical content framework, Bunch's (2013) pedagogical language knowledge, Biesta's et al. (2015) teacher agency framework, and Moersch's (1997) levels of technology implementation framework. In the quantitative phase, data was collected with an original survey, and in the qualitative phase, data was generated through observations, interviews, and artifacts. Survey responses were analyzed using descriptive statistics. The qualitative data was analyzed using descriptive and in vivo coding. Codes were used to develop emergent themes. Overall, the DL teachers leveraged technology in various ways for planning, instruction, and assessment supporting their students' academic achievement by building background knowledge, introducing concepts with comprehensible input, and providing vocabulary practice. They also used different digital tools to develop students' sociocultural competence by building a strong classroom community, incorporating students into the curriculum, and teaching about different cultures. Moreover, the participants used technology to communicate with parents and seek professional development opportunities. DL teachers' technology use was influenced by contributing and inhibiting contextual factors. Practical implications stipulated include providing DL teachers with appropriate planning time, supporting teachers with professional development that is relevant to DL and encouraging effective technology integration, allowing for curriculum flexibility, and investing in resources in the partner language.

LEVERAGING TECHNOLOGY TO SUPPORT THE GOALS OF DUAL LANGUAGE BILINGUAL EDUCATION: AN EXPLANATORY SEQUENTIAL MIXED METHODS STUDY

CHAPTER 1

INTRODUCTION

The student population in the United States (U.S.) is growing more culturally and linguistically diverse. Currently, about 10%, or 5 million students within the U.S. public school system, fall under the categorization of English learners (ELs; National Center for Education Statistics [NCES], 2022), a term traditionally used to describe these culturally and linguistically diverse students. However, there is a growing preference for referring to these students as "emergent bilinguals" or "multilingual learners" instead, primarily because the EL label has been criticized for perpetuating a deficit mindset and for placing undue emphasis on English as the dominant language (García et al., 2008). I prefer the term emergent bilinguals because it values the students' home language and culture. Emergent bilinguals speak a native language and are in the process of learning English. To address the unique needs of these students, many school districts have adopted dual language (DL) programs, which promote bilingualism, biliteracy, grade-level academic achievement, and sociocultural competence (Howard et al., 2018). In DL programs, students receive instruction in both English and a partner language (e.g., Spanish) across the content areas, with at least 50% of instructional time in the partner language (Thomas & Collier, 2012). To support the biliteracy goal, students receive literacy instruction in both program languages. Emergent bilinguals particularly benefit from such programs because they build English proficiency while continuing to learn in their home language. Emergent bilinguals in DL programs usually achieve higher on state tests and develop higher proficiency in English when compared to their peers receiving English-only instruction.

As technology becomes a more integral part of our daily lives and education, authors of the *Guiding Principles for Dual Language Education* (Howard et al., 2018) recommended that technology be used effectively to support curriculum and instruction. Furthermore, growing research literature documents the benefits of integrating digital tools with emergent bilinguals, including increasing engagement, providing learning supports, promoting language development and content knowledge, and increasing creativity and student agency (e.g., Martínez-Álvarez et al., 2012; Pandya et al., 2015; Rowe & Miller, 2016). Given the prevalence of digital technologies in the 21st century, all students must be given the opportunity to become competent at using a variety of technological tools (Rowe & Miller, 2016). Since many emergent bilinguals lack access to computers and the Internet at home, access to technology-based learning experiences in schools becomes a matter of equity.

Technology offers many affordances for emergent bilinguals, for instance, emergent bilinguals can use diverse digital tools to show their learning in innovative ways; they can collaborate with others inside and outside the classroom; and they can become creators of digital products instead of just being consumers in digital spaces (Martínez-Álvarez et al., 2012; Pandya et al., 2015). Additionally, recognizing the ubiquitous nature of technology, Howard and colleagues (2018) recommended that in DL programs, technology be effectively integrated into the curriculum to deepen and enhance students' learning. They suggested that DL teachers integrate technology frequently to provide high-quality, current, and relevant curriculum resources such as images, videos, primary sources, and simulations. The authors also proposed that DL teachers create technology-based lessons using digital tools such as interactive games, collaborative applications, and social media to meet content and language standards in both languages of the program.

Statement of the Problem

Research on how DL teachers integrate technology is limited (de la Piedra, 2010; Ghiso et al., 2014; González-Carriedo & Esprívalo Harrell, 2018; Martínez-Álvarez, 2017a, 2017b; Martínez-Álvarez et al., 2012; Mercuri & Ramos, 2014; Pandya, 2018; Pandya et al., 2015; Patthoff et al., 2021). Additionally, the extant research primarily consists of studies in which researchers partnered with teachers to implement technology-based activities (e.g., Ghiso et al., 2014; Pandya, 2018). These studies provide pertinent examples of how technology tools can support the goals of DL; however, investigations on how DL teachers use technology in their natural setting—that is, without a researcher's intervention—are almost nonexistent.

The most recent study focused on how elementary DL teachers used technology to enhance mathematics learning and mathematical discourse (Patthoff et al., 2021). Although the researchers did not collaborate with the teachers during instruction, they led year-long professional workshops in which the teachers participated. The series of workshops focused on integrating math and language and in some workshops, technology was discussed as a tool to accomplish that. Patthoff and colleagues found that only 5 out of the 21 DL teachers used technology strategically to encourage mathematical discourse. Some strategic uses included using digital models to visualize math concepts and allowing students to use different digital tools to show and explain their problem-solving strategies.

The sole study exploring DL teachers' use of technology without researchers' interventions was conducted by González-Carriedo and Esprívalo Harrell (2018). Their study focused on DL teachers' beliefs about technology integration and their perceptions of whether or not technology could enhance their students' bilingualism and biliteracy. The researchers found that while DL teachers were comfortable using computers and showed a positive attitude toward

technology, they recognized that they were not as comfortable using technology with tasks that engaged students in higher-order thinking skills.

Although DL greatly improves student academic achievement (Howard et al., 2018; Thomas & Collier, 2012), and technology enhances emergent bilinguals' learning experiences (e.g., Mercuri & Ramos, 2014; Pandya et al., 2015), we have yet to learn more about how DL teachers use technology. Understanding the different ways DL teachers use technology, and the factors that influence their decision-making when using technology might help other teachers improve their practices. This knowledge might also guide educational leaders in building teachers' capacity, promoting structures that contribute to teachers' effective use of technology, and removing barriers that hinder teachers' effective use of technology.

Purpose Statement

Considering the affordances technology offers to DL teachers and students in addressing content and language objectives (Martínez-Álvarez et al., 2012; Mercuri & Ramos, 2014), the purpose of this mixed methods sequential explanatory study was to explain how and why DL teachers use technology. The quantitative strand of this study aimed to describe the different ways DL teachers use technology and the factors that influence their use of technology. A quantitative component was needed to understand DL teachers' use of technology at a larger scale. The qualitative strand intended to explore DL teachers' decision-making process for technology use and to what extent teachers' use of technology supports the goals of DL. The integration of quantitative and qualitative results provided a more comprehensive view of how and why DL teachers use technology.

Conceptual Framework

As teachers of content and language, DL teachers need different types of knowledge to provide effective instruction for their students including *pedagogical content knowledge* (PCK) and *pedagogical language knowledge* (PLK; Bunch, 2013). PCK refers to knowing how to teach a particular content subject. It includes the topics covered in the subject matter and the appropriate teaching and learning methods for the specific subject (Mishra & Koehler, 2006). PLK refers to knowing how to teach the language of a content subject (Bunch, 2013). Teachers of emergent bilinguals need a specific type of knowledge about language including an understanding of the language they teach, linguistics, second language acquisition, and bilingualism. DL teachers rely on both PCK and PLK when making instructional decisions. For instance, a DL teacher who teaches math in Spanish should know the different approaches for teaching multiplication and division, the different strategies students might use to solve multiplication and division problems, the key vocabulary related to multiplication and division in Spanish, and the language structures in Spanish students need to explain their reasoning for solving multiplication and division.

Since DL teachers are expected to integrate technology, they also need *technological pedagogical content knowledge* (TPACK; Mishra & Koehler, 2006). TPACK encompasses the technological, pedagogical, and content knowledge teachers need to implement technology successfully. Additionally, TPACK emphasizes the interconnections among knowledge of a content area, specific pedagogical approaches, and technology to create content-based instruction with digital technologies. Therefore, effective technology integration approaches should reflect subject matter knowledge, the teaching and learning methods for developing such knowledge, and consideration of the classroom and school contexts (Harris et al., 2009). DL teachers draw

from TPACK when making decisions on how to teach a topic within a content area and how to integrate digital tools to support students' content learning and language development.

Because DL teachers draw on different forms of knowledge such as knowledge about content, language, pedagogy, and technology; they take an active role in shaping the learning experience of their students. DL teachers must make choices and instructional decisions daily as they work to meet the needs of their learners. These include decisions about what resources to use for planning, what instructional strategies to apply, what technologies to use to support their planning and instruction, and how to fairly assess their students. When making instructional decisions, DL teachers exercise their agency; that is, they make active contributions to their work and their environment (Biesta et al., 2015). Teacher agency is shaped by the teachers' beliefs, values, educational philosophy, and their institutional context and culture. Since DL teachers have to make decisions in response to current demands or situations (e.g., DL program implementation, district requirements, students' needs), their agency emerges from their interactions with their context (e.g., classroom, school, district). Moreover, teachers' agency is influenced by their future goals, which can be short or long-term and are framed by the teachers' aspirations and concerns. For instance, DL teachers' agency might be related to supporting their students' academic growth so that they reach grade-level or higher achievement (short term) and elevating the partner language status to counteract English hegemony (long term). Thus, DL teachers' use of technology is linked to the different types of knowledge they draw from including content, pedagogy, language, and technology, as well as their enactment of agency when making instructional decisions.

I used the levels of technology implementation (LoTi) framework (Moersch, 1997) as a lens for looking at DL teachers' use of technology. The LoTi framework focuses on *technology*

efficiency, or the degree to which technology is used to support instruction and higher-order thinking skills (e.g., solving real-world problems, and interpreting data). The LoTi framework includes six levels of technology efficiency, ranging from Level 0 (*non-use*) to Level 6 (*refinement*). As levels increase there is a shift in instruction from teacher-centered to student-centered. In lower levels of implementation, technology is used to supplement or expand instruction (e.g., tutorials, simulations). In higher levels of implementation, technology is used to empower students to create products (e.g., teachers create technology-based units, students develop multimedia presentations) and extend learning outside of the classroom (e.g., collaborating with other schools or organizations). Contextual factors such as lack of time or inadequate professional development can negatively affect teachers' level of technology implementation. In the next section, I describe the research questions that emerged from a comprehensive literature review, and that are guided by the conceptual framework previously explained.

Research Questions

Creswell and Plano Clark (2017) suggested that a mixed methods study addresses a combination of question types: an overarching question that guides the whole study; and specific questions linked to quantitative and qualitative methods. I aimed to answer the following research questions:

- Overall R.Q.: How and why do DL teachers use technology?
- Quantitative R.Q.1: In what ways do DL teachers use technology?
    - 1a: In what ways do DL teachers use technology for planning?
    - 1b: In what ways do DL teachers use technology for instruction?
    - 1c: In what ways do DL teachers use technology for assessment?

    - 1d: In what other ways do DL teachers use technology?
- Quantitative R.Q.2: What factors influence teachers' use of technology?
- Qualitative R.Q.1: How do DL teachers describe their decision-making when using technology?
- Qualitative R.Q.2: To what extent do DL teachers use technology to support the goals of DL?

Significance of the Study

The results of this study provided a significant contribution to the underdeveloped area of research related to teachers' use of technology in DL classrooms while supporting the goals of DL and the needs of their students. This study also contributed to future research by posing appropriate questions for further exploration. This study was particularly important because no existing studies have focused on the different ways DL teachers use technology on a larger scale or their decision-making process when using technology. Knowledge and understanding of the ways and the reasons why DL teachers use technology provided additional insight into effective instructional practices in DL and for teacher training efforts in this area.

A study of this kind was significant to DL teachers because it provided specific examples of how participants use technology for planning, instruction, and assessment, as well as what digital tools are helpful in DL. The results of this study enhance DL teachers' practices by illustrating technology use that supports bilingualism, biliteracy, academic achievement, and sociocultural competence. Since I also focused on factors that influenced DL teachers' use of technology, the results of this study guide educational leaders and policymakers by capitalizing on factors that contribute to the DL teachers' use of technology and addressing those factors that present challenges. Moreover, this study yielded valuable findings due to its mixed methods

research design. The integration of both quantitative and qualitative approaches provided a deeper insight into technology use in DL, first, by identifying the different ways DL teachers use technology and the factors that influence their use of technology, and then, by expanding on participants' responses by exploring follow-up questions regarding participants' decision-making.

Definitions of Terms

Biliteracy is the "ability to read and write with high proficiency levels in two languages through the appropriate and effective use of grammatical, syntactic, graphophonic, semantic, and pragmatic systems of the two languages" (Escamilla et al., 2014, p. 181).

Dual language programs are enrichment programs in which students receive instruction in English and another language (partner language; Thomas & Collier, 2012). The two languages are taught through the curriculum, and students receive at least 50% of instruction in the partner language. DL programs foster bilingualism and biliteracy, grade-level academic achievement, and sociocultural competence for all participating students (Howard et al., 2018).

Dual language teachers are teachers who provide instruction in DL programs. Some DL programs use a team-teaching approach, in which languages are separated by teachers (Thomas & Collier, 2012). Therefore, there is a teacher who provides instruction in English and a teacher who provides instruction in the partner language (e.g., Spanish, Mandarin). Sometimes, DL teachers are self-contained; thus, they teach in both program languages. DL teachers are teachers of content (e.g., math, science, reading, writing) and teachers of language.

Funds of knowledge refer to "competence and knowledge that youth acquired through their life experiences" (de la Piedra, 2010, p. 575).

Emergent bilinguals are students usually referred to as *English learners* (ELs). These students speak a home language other than English and are learning English at school. Therefore, these students become bilingual because they continue to use their home language and English, their new language (García et al., 2008).

Metalinguistic awareness, also known as *metalanguage*, refers to "thinking and talking about language…understanding the relationships between and within languages" (Escamilla et al., 2014, p. 67). Metalinguistic awareness is a language skill that enables students to construct meaning and develop vocabulary.

Multimodality is the combination of different modes (e.g., text, image, video, voice) to convey meaning or a message (Elola & Oskoz, 2017).

Partner language, also known as *target language*, refers to a second language, other than English, used in a DL program to teach the curriculum (Thomas & Collier, 2012). For instance, many DL programs provide instruction in Spanish and English; in this case, Spanish is the partner language.

Sociocultural competence refers to positive identity development, knowledge about one's and others' cultures, and multicultural appreciation (Howard et al., 2018).

Student-centered technology approach is when the teacher takes on a facilitator role (Pandya et al., 2015). Instead of students taking a passive role and being only consumers of digital products, students are given opportunities to become designers by using different technology tools to create digital products.

Teacher agency refers to the actions teachers take in response to their context (Biesta et al., 2015). Teachers' agency is shaped by their beliefs, values, their educational philosophy, and their institutional context and culture.

Translanguaging refers to the cognitive processes bilinguals engage in when making meaning of their world (García et al., 2016). There's no strict separation of languages in the bilingual brain. Bilinguals' use of language is fluid and dynamic, therefore, bilinguals learn new concepts and communicate using their whole linguistic repertoire.

CHAPTER 2

REVIEW OF RELATED LITERATURE

In this chapter, I provide a review of existing research conducted on how dual language (DL) teachers can use technology to support the goals of DL. Mishra and Koehler's (2006) technological pedagogical content framework (TPACK), Bunch's (2013) pedagogical language knowledge (PLK), Biesta et al.'s (2015) teacher agency framework, and Moersch's (1997) levels of technology implementation (LoTi) framework have been used as the conceptual frameworks guiding this study. Using these lenses, I discuss empirical articles related to the purpose of this study of explaining how and why DL teachers use technology. First, I provide an overview of DL programs followed by a description of the different types of knowledge DL teachers need. Next, I discuss how technology has been used in DL to support students' language development, academic achievement, and sociocultural competence. In the last section, I address the factors that influence DL teachers' use of technology.

DL Programs

In this study DL refers to "any program that provides literacy and content instruction to all students through two languages and that promotes bilingualism and biliteracy, grade-level academic achievement, and sociocultural competence" (Howard et al., 2018, p. 3). The reasoning behind DL is that students can successfully learn a second language if it is taught for long periods of time and used for meaningful communication in school, similar to the way children learn their first language at home (Genesee & Lindholm-Leary, 2007). Both program languages are taught naturally across the curriculum content areas, and students receive at least 50% of

instruction in the partner language (e.g., Spanish, Chinese; Thomas & Collier, 2012). There are approximately 3,650 DL programs in the United States, and Spanish is the most frequent partner language (about 80%), followed by Chinese (about 9%), and French (5%; American Councils Research Center, 2021).

DL programs vary according to the demographics of students participating in them, and the structure of language time allocation (Thomas & Collier, 2012). Depending on the students' demographics, DL programs can be one-way, or two-way (Howard et al., 2018). Some one-way programs serve native or heritage speakers of the partner language, these programs are usually referred to as developmental bilingual programs. Other one-way programs serve students who are all English native speakers, these programs are usually known as foreign or world language immersion. In two-way programs about half of the students are English native speakers and half are native speakers of the partner language. Students might also be proficient in both languages. One-way developmental bilingual programs and two-way programs are characterized by additive bilingualism; that is, students learning a second language does not come at the expense of their first language (Genesee & Lindholm-Leary, 2007).

Moreover, DL programs can be classified as 90:10 or 50:50 according to how much instructional time is provided in the partner language (Genesee & Lindholm-Leary, 2007; Thomas & Collier, 2012). In 90:10 programs, initially, 90% of instruction is provided in the partner language, so students learn how to read in the partner language first. Students are taught reading in English beginning in third grade. The amount of English instruction increases by grade level until both languages reach a 50% ratio (usually around third or fourth grade). A 50:50 program provides 50% of instructional time in English and 50% in the partner language throughout the whole length of the program. Students might start by learning how to read in their

first language and later in their second language (Grades 2-3), or they learn how to read simultaneously in both program languages.

DL programs enhance the learning experiences of all students, as participating students usually reach higher academic achievement than their peers who are not in DL (Thomas & Collier, 2012). Native English speakers including students considered "at-risk" benefit from academic gains and learning a second language (Genesee & Lindholm-Leary, 2007; Thomas & Collier, 2012). DL provides equity to emergent bilinguals by reinforcing their native language skills to support their English language development (Howard et al., 2018). Thus, emergent bilinguals in DL programs usually score higher on standardized tests and reach higher levels of English proficiency than their peers in English-only instruction (Thomas & Collier, 2012).

DL is characterized by the promotion of equity and social justice (Howard et al., 2018; Thomas & Collier, 2012). Treating all students equitably and fairly requires an understanding of culturally, linguistically, and socioeconomically diverse students. Emergent bilinguals and heritage language speakers of the partner language benefit from reaching grade-level achievement and developing positive bilingual and bicultural identities. Therefore, students' cultures should be valued and celebrated in the classroom and school environments. Students' funds of knowledge should be incorporated into the curriculum (de la Piedra, 2010) through multiethnic grade-level resources and materials in English and the partner language (Howard et al., 2018). In the next section, I address the different types of knowledge a DL teacher requires.

DL Teachers' Knowledge

Some DL programs use a team-teaching approach, in which languages are separated by teachers (Thomas & Collier, 2012). Therefore, there is a teacher who provides instruction in English and a teacher who provides instruction in the partner language. Sometimes, a teacher

might teach in both program languages, this teacher is usually referred to as a self-contained DL teacher. Instruction in DL is very complex; DL teachers teach language through content (e.g., math, science, reading, and writing) while supporting the goals of DL and the diverse needs of their students (Howard et al., 2018). Hence, DL teachers need to be knowledgeable of curriculum, assessment, technology, and instructional strategies that support bilingualism, biliteracy, academic achievement, and sociocultural competence.

As teachers of language learners, DL teachers need different types of knowledge to provide effective instruction including *pedagogical content knowledge* (PCK; Shulman, 1986) and *pedagogical language knowledge* (PLK; Bunch, 2013). PCK refers to knowing how to teach a particular content subject (Shulman, 1986). PLK refers to knowing how to teach the language of a content area (Bunch, 2013) while considering how language is used for different purposes and in different social settings (Halliday & Matthiessen, 2013). Additionally, since DL teachers are expected to integrate technology (Howard, et al., 2018), they need *technological pedagogical content knowledge* (TPACK; Mishra & Koehler, 2006). TPACK encompasses the intersection between the technological, pedagogical, and content knowledge teachers need to implement technology successfully. In the next section, I explain PCK, TPACK, and PLK in further detail.

PCK

When describing the different types of knowledge a teacher requires, Shulman (1986) claimed that teachers need both content and pedagogical knowledge. Content knowledge is the knowledge of a subject matter (e.g., math, science) that includes the concepts taught and the structure of the subject. Teachers need to know the different topics, theories, and procedures covered in the subject matter in the particular grade and content area they teach. Meanwhile, pedagogical knowledge refers to the knowledge about teaching and learning methods and

strategies, including one's educational values and goals (Mishra & Koehler, 2006). Pedagogical knowledge includes knowledge about student learning, lesson planning, instruction, classroom management, and assessment.

PCK is knowledge of teaching approaches that are appropriate for teaching a particular content area (Mishra & Koehler, 2006). PCK includes knowledge of "the most regularly taught topics in one's subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations" (Shulman, 1986, p.9). Additionally, PCK involves an understanding of why some concepts are difficult or easy to learn, and knowledge of students' prior knowledge. Understanding students' background knowledge is important because often students' prior knowledge includes misconceptions and teachers need to know the best strategies to address these misconceptions. Therefore, teachers draw from PCK to make instructional decisions about specific content topics and how to best support their students' learning. For instance, when teaching the water cycle, a teacher might plan for an investigation in which students can observe and record the water cycle process as science concepts are best learned inductively and by applying the scientific method.

TPACK

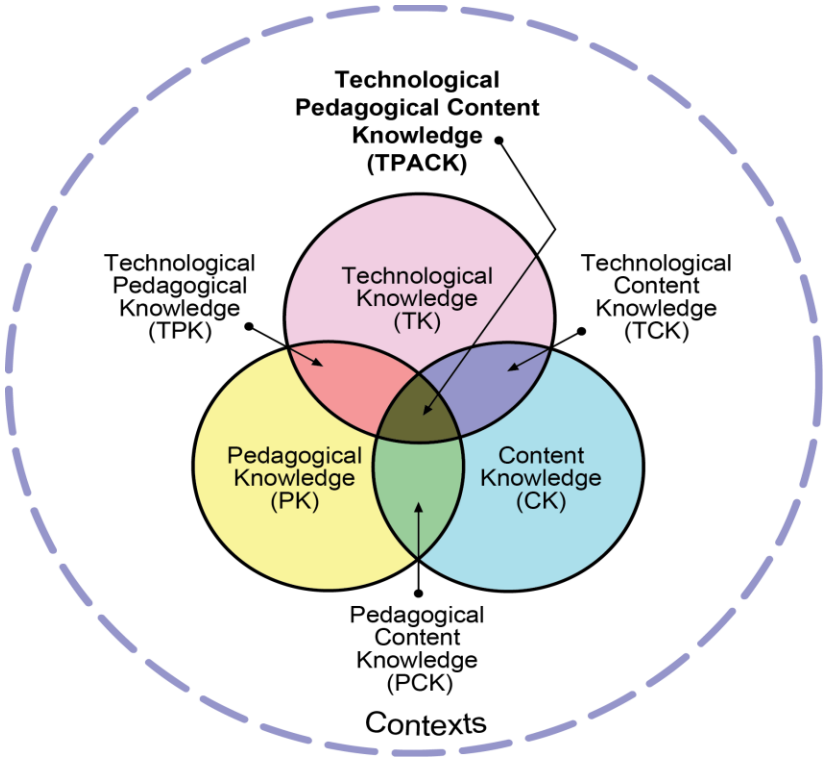
Although Shulman did not explicitly discuss technology in PCK, technology was subsumed in PCK because a variety of non-digital technologies were available in the classrooms such as textbooks, charts, and overhead projectors (Mishra & Koehler, 2006). The appearance of new digital technologies brought technology to the forefront of education. Mishra and Koehler (2006) argued that the expanding range of technologies available for instructional use required learning how to apply them to teaching and learning. The authors claimed that a theoretical

grounding was needed for understanding the relationship between technology and teaching, thus, they introduced the TPACK framework.

Mishra and Kohler (2006) claimed that purposeful uses of technology in education require the development of a complex knowledge base that emerges from the intersection of three forms of teacher knowledge: content, pedagogy, and technology. Figure 1 illustrates the three forms of knowledge and the multiple interactions among them resulting in pedagogical content knowledge, technological content knowledge, technological pedagogical knowledge, and technological pedagogical content knowledge. The dotted circle represents the contextual factors of the classroom or school settings that influence what teachers do, and what students learn (Harris et al., 2009).

Figure 1

Technological Pedagogical Content Knowledge



Note. From "TPACK Images," by M. J. Koehler, 2011. (tpack.org). Copyright 2012 by tpack.org. Reprinted with permission.

The TPACK framework represents the interactions of content knowledge (CK), technological knowledge (TK), and pedagogical knowledge (PK). Technological knowledge includes the knowledge of non-digital technologies such as a blackboard, chalk, and books as well as digital technologies such as computers, mobile devices, and the Internet (Mishra & Koehler, 2006). The knowledge of digital technologies includes both knowledge of hardware (e.g., how to connect to peripherals) and software (e.g., how to use programs such as word processors, spreadsheets, and slide decks). Since technology tools change rapidly, technology knowledge includes learning and adapting to new technologies, which might be difficult for teachers due to time constraints (Harris et al., 2009). Due to its evolving nature, TK goes beyond

computer literacy, it includes the mastery of technology for processing information, communication, and problem-solving.

The interactions of technology with content knowledge results in technological content knowledge (TCK), while the interaction of technological and pedagogical knowledge results in technological pedagogical knowledge (TPK; Mishra & Koehler, 2006). TCK involves teachers knowing how the teaching of a subject matter can be modified by using certain technology tools. For instance, science simulations change the way teachers can teach certain concepts by enabling new ways of representing the concept and allowing students to interact with it. So, ecosystems and the interrelations of their organisms might be taught by using ecosystem simulations in which students can manipulate their components (living and non-living things) and study the effects of the changes in the ecosystem (Pierson & Grapin, 2021). TPK is the knowledge of how technology can be used for teaching and learning. It includes the understanding of how technologies can be used for specific tasks or teaching strategies. TPK includes knowledge of tools for attendance, grading, discussion boards, content-specific applications, and student response systems, among others. TPK is characterized by creativity and flexibility so teachers can apply digital tools for advancing student learning and understanding (Harris et al., 2009). When teachers draw from TPK they structure learning in specific ways so that students can use technology efficiently as well. For instance, a teacher might encourage students to use collaborative digital tools such as slide decks to foster small group discussion and collaborative group work by also assigning specific roles to each group member.

From the multiple interactions among the three different types of knowledge, content, pedagogy, and technology, emerges TPACK. Mishra and Koehler (2006) argued that there is no generic solution for technology integration that applies to every teacher, or every subject.

Therefore, “quality teaching requires developing a nuanced understanding of the complex relationships between technology, content, and pedagogy, and using this understanding to develop appropriate, context-specific strategies and representations” (p. 1029). The relationship among content, technology, and pedagogy is complex and dynamic; a change in one component usually means a change in the other two. When new content knowledge emerges, technology and pedagogy have to be adjusted to address this change. Likewise, when new technology becomes available, new opportunities for content and pedagogy might become possible.

TPACK allows teachers to use digital tools to represent knowledge in innovative ways, enhance instructional strategies, and build on existing prior knowledge to improve the understanding of content (Ronan, 2018). Teachers who are technologically and pedagogically proficient and curriculum-oriented put TPACK into practice when they plan for instruction and when they teach (Harris et al., 2009). For instance, a teacher applying TPACK might plan for an artifact-based inquiry activity when teaching about an ancient civilization in social studies. Students can use artifact kits, online museums and exhibitions, or video games to learn about the civilization. Students can then report what they have learned in whole group discussion in a visual representation or a written report.

TPACK has been used as a theoretical framework in several studies involving teachers’ use of technology. For example, TPACK was used to frame studies exploring the different ways English as a second language teachers use technology tools to support language learning (e.g., Sharp, 2017). A systematic review of empirical studies of TPACK application in English as a second language and English as a foreign language revealed an increase in TPACK publications addressing different levels of contextual factors needed for effective technology integration (Greene & Jones, 2020). The systematic review showed that there are many areas for advancing

the application of TPACK including studies on students learning in different contextual settings, and how contextual factors influence TPACK knowledge development. TPACK has also been applied as a framework with general education teachers serving both English native speakers and emergent bilinguals while using technology to teach content and language (e.g., Anglin, 2017; Li, 2020). Furthermore, TPACK has been employed in second language acquisition contexts of languages other than English. In a study exploring the experiences of Spanish language teachers (Grades 7-12) participating in technology professional development, TPACK served as a guide for developing the professional development, and as a lens in the data analysis process (Bustamante, 2020).

When teachers draw on TPACK for instructional decisions they consider content, pedagogy, technology, and their specific contexts (Harris et al., 2009). For teachers of emergent bilinguals, TPACK includes an understanding of language development as a content area (CK), instructional strategies to support language teaching (PK), and effective use of technology tools to support language development (TK; Ronan, 2018). Therefore, the application of TPACK in contexts with emergent bilinguals requires the consideration of knowledge about language development. I address this in the section below.

PLK

Teachers of emergent bilinguals need a specific type of knowledge about language including understanding about the language they teach, linguistics, second language acquisition, and bilingualism (Bunch, 2013). This knowledge has been conceptualized as PLK. PLK is the "knowledge of language directly related to disciplinary teaching and learning and situated in the particular (and multiple) contexts in which teaching and learning take place" (p. 307). PLK refers to the knowledge of how language works within a specific content area. For instance, a teacher

needs PLK to teach students to identify and analyze the linguistic features of comparative clauses in math or the passive voice structure of science informational texts (Ronan, 2018). PLK serves as a foundation for teaching practices that support content mastery and language development in emergent bilinguals (Kidwell et al., 2021).

DL teachers need PLK to be able to effectively teach in their target language, to make content comprehensible, and to support the language development of their students. Simply being fluent in the target language does not guarantee a teacher's ability to efficiently teach that language. In a study of a fifth-grade DL teacher's development of PLK, Barko-Alva (2022) found that when planning for Spanish language arts instruction, the teacher needed to understand the academic concepts and the discipline-specific language needed for the lesson. Although the DL teacher made use of her whole linguistic repertoire, she struggled to find certain language arts vocabulary terms in Spanish. This made lesson planning difficult because she could not find adequate resources to teach the concept. In turn, the lack of PLK resulted in a lesson in which, after completion, students still needed further scaffolding and understanding. Thus, DL teachers need to develop their metalinguistic awareness—that is, in-depth understanding of language structures within a language and between languages (Escamilla et al., 2014), and their PLK to effectively plan for and deliver instruction in their target language.

DL teachers draw from the different types of knowledge (PCK, TPACK, and PLK) when they engage in lesson planning when they select what resources to use, including digital and non-digital, and what instructional strategies to apply. DL teachers draw from the different types of knowledge when they use technology to deliver a lesson, and when they engage students in independent practice using digital and non-digital tools. In the next section, I explain how

technology can be used in DL contexts to support language development, academic content knowledge, and sociocultural competence.

Technology in DL

An extensive review of the literature revealed that technology enables DL teachers to foster students' language development through biliteracy centers (Mercuri & Ramos, 2014), multimodality (e.g., Pandya, 2018), and translanguaging (e.g., Martínez-Álvarez, 2017a). DL teachers also use technology tools to promote academic achievement (e.g., González-Carriedo & Esprívalo Harrell, 2018) and sociocultural competence by honoring students' funds of knowledge (e.g., Martínez-Álvarez et al., 2012), fostering positive students' identities (Pandya et al., 2015), and engaging students' families. I explain these different uses of technology in DL in the following subsections. I also address how DL teachers' approaches to technology integration might differ by applying the LoTi framework (Moersch, 1997).

Supporting Students' Language Development

In DL programs teachers and students work to meet or exceed the content standards for reading, math, science, and social studies, while developing deeper language proficiency skills in two languages (Thomas & Collier, 2012). Thus, students need to be engaged in activities that develop the four language domains (i.e., speaking, listening, reading, and writing) as well as their metalinguistic awareness. This fifth language skill, also known as metalanguage, is "thinking and talking about language…understanding the relationships between and within languages" (Escamilla et al., 2014, p. 67). Metalinguistic awareness enables students to analyze and leverage language to construct or expand knowledge and express meaning. González-Carriedo and Esprívalo Harrell (2018) found that DL teachers believe that technology has the potential to support students' language development. For instance, students can listen to audio, they can

translate, or use tools such as digital dictionaries and encyclopedias. Similarly, students can use applications to practice using content academic language in both program languages in virtual spaces. For example, students can use screencasting to share how they solve math problems (Patthoff et al., 2021). This strategic use of technology enables students to practice speaking in the target language without feeling anxious about public speaking. DL teachers might use technology to support students' language development through integrated biliteracy centers, multimodality, and translanguaging.

Integrated Biliteracy Centers. DL teachers can use technology to enhance students' development of language skills through content practice. Mercuri and Ramos' (2014) study showed that DL teachers can implement technology-based integrated biliteracy centers. In collaboration with researchers, a second-grade DL teacher implemented three different centers. In the *a book about* center, the goal was to compose a book in English. Students had to write word problems using science vocabulary. They used a book as a model, then composed it on paper, and finally published it using background images, pictures, and text on Storybird.com. Another center, *flip with a twist*, was designed to practice oral language skills in both English and Spanish. Here students work in small groups to record a math mini-lesson explaining a concept (already learned in class) using manipulatives. The class shared access to the videos created and students could provide peer feedback. Finally, the *poster with Glogster* center challenged students to develop reading comprehension skills in Spanish. Students worked in pairs to research a U.S. hero. After learning about different figures through videos, the pair chose a person to investigate using the internet and books. Students took notes and determined what information to include on their final digital poster. The centers implemented in the study illustrated how students could develop biliteracy by reading and writing in different languages,

searching for information online, having choices, and creating a product. Additionally, the products created served as formative assessments because the teacher could analyze them and monitor students' biliteracy progression.

Another way to support students' language development is through multimodality, or the combination of different modes (i.e., text, image, video, voice) to convey meaning or a message (Elola & Oskoz, 2017). Multimodality enables emergent bilinguals to enhance their understanding, and find creative ways to express their knowledge, while they are still developing their language skills (Smith et al., 2021). For example, a student whose reading and writing skills are still emerging might use images, audio, or speech to support their learning. Multimodality is described in more detail in the next section.

Multimodality. The notion of multimodality is not new as "classrooms themselves are multimodal spaces," since they are filled with posters, images, texts, talk, body posture, gestures, anchor charts, and student work (García & Kleifgen, 2018, p. 91). When technology is added to multimodality, students can then use resources that go beyond the classroom. When engaged in the creation of multimodal digital compositions students take active roles as designers integrating different modes (e.g., textual, aural, visual) to communicate meaning using diverse digital tools (Elola & Oskoz, 2017). Multimodal digital compositions offer alternative ways of instruction, learning, production, and assessments. These alternatives have the potential to disrupt traditional and test-centered education in which students are passive learners by positioning emergent bilinguals as designers and creators (Pandya et al., 2015).

When students engage in multimodality, they can practice all their language domains (i.e., listening, speaking, reading, writing, and metalinguistic awareness), thus enhancing their language development (Pandya, 2018). Ghiso and colleagues (2014) studied how students

created digital comics with pictures, storytelling (e.g., voice recording), and text. For pictures, students used pictures they brought from home, stock images from the internet, drawings they made, or a combination of any of these. DL teachers facilitating this kind of activity discussed how the pictures helped students with their writing by helping them generate ideas and staying on topic as they had to write describing what was on the pictures. A similar multimodal activity involves students in movie creation. For instance, students can create autobiographies using movie-making applications such as iMovie. Students might use photos, drawings, and images from the internet; include text to label their pictures; record their voices or video recordings of themselves; and add music and sound effects (Pandya et al., 2015). Students can organize their ideas in writing to remember their lines (when recording their voices). Students enjoy such projects because it is important to them to talk about themselves, their families, their birthplaces, their memories, and their future plans.

Multimodal digital compositions can be considered critical literacies as students are required to think critically about what kind of products they are making, what elements they incorporate in the compositions, what message they are trying to convey, and who their audience is (Pandya, 2018). When taking a critical digital literacy approach, technology is not used to merely replicate usual dominant literacy practices and products. Instead, technology affords innovative literacy practices that result from students' interactions with multimodal expression (Ghiso et al., 2014; Pandya et al., 2015). Students can take critical stances and address matters of social justice by making compelling arguments. For instance, in a charter school on the verge of closing, students created videos titled *Save Our School* to persuade authorities to keep their school open (Pandya, 2018). Students worked in groups to create videos incorporating pictures brought from home, pictures taken around the school, and interviews they conducted with other

students and teachers. Students' reasons for keeping their school open included electives and activities for self-expression, support for bilingualism, and personal connections with students, teachers, and staff. Students were able to exploit the affordances of multimodality to support their claims, including the use of sentimental music, emotional testimonials and interviews, and evocative photos of children smiling.

In the case of emergent bilinguals, the different languages they navigate also become part of the modes employed in multimodality along with images, sound, and audio recordings (Smith et al., 2017). Therefore, creating multimodal compositions enables emergent bilinguals to translanguage. Translanguaging includes "multiple discursive practices in which bilinguals engage to make sense of their worlds" (García, 2011, p. 45). In the next section, I explain translanguaging in more depth and provide examples of how digital tools can support translanguaging.

Translanguaging. Since bilinguals are not two monolinguals in one—that is, there is no complete language separation—bilinguals' use of language is fluid and dynamic (García et al., 2016). Translanguaging refers to the cognitive processes bilinguals engage when constructing meaning and communicating using their entire linguistic repertoire. A translanguaging approach enables teachers to draw on their whole linguistic repertoire and to engage their students' entire linguistic repertoires including code-switching, and vernacular forms of language (García-Mateus & Palmer, 2017). Translanguaging can be employed as a pedagogy to (a) support students' comprehension of complex curriculum content and texts, (b) give students opportunities to practice academic language, (c) provide a space for students' bilingualism and different ways of knowing, and (d) develop students' bilingual identities (García et al., 2016). Strictly separating the language of instruction can inhibit students' willingness to take linguistic

risks and engage in discussion (García-Mateus & Palmer, 2017). Nevertheless, the minority language in DL programs needs to be protected to counteract English dominance (Howard et al., 2018).

Emergent bilinguals benefit from using technology in a way that recognizes their whole linguistic repertoire. Encouraging emergent bilinguals to translanguage while using digital tools to learn, create, and share, enables educators to use technology through a student-centered approach by developing a classroom environment in which students are co-creators of knowledge (España, 2016). Many digital tools can facilitate students' translanguaging and support their role as designers. For instance, slide decks can be used for bilingual presentations and translation applications can be used to support the writing process. Additionally, a teacher can encourage the use of collaborative writing applications to facilitate student collaboration and provide students with immediate constructive feedback. Social media can also be used for discussions, and applications such as Goodreads or Epic can be used for reading books online and writing book reviews. Furthermore, teachers can use tools such as digital cameras and comic-making software to encourage translanguaging (Martínez-Álvarez, 2017a). Students might use digital cameras to take pictures of their family members or people and places in their community and use these pictures to create digital comics. Students might use different languages to represent the language spoken by the person or the language spoken in a particular space. Thus, students can integrate their social contexts (e.g., home, community, school) visually and with words in an authentic manner. In the next section, I address how technology can also be leveraged to support students' academic achievement.

Supporting Students' Academic Achievement

In DL, technology can be used to support the curriculum and instruction to deepen and enhance students' learning. For instance, technology can be used regularly to provide high-quality and relevant curriculum resources such as images, videos, and virtual field trips. DL teachers usually use technology tools to help them deliver instruction and provide non-linguistic supports (Howard et al., 2018). In my qualitative pilot study, the DL teacher employed technology to make language more comprehensible by using the interactive whiteboard, digital images, and videos. She used her document camera to show the pages of the book she was reading, to teach a math lesson using manipulatives, and to model how to complete an activity. Patthoff and colleagues (2021) found similar results in the ways DL teachers used hardware to model math instruction, but in their study, students also used the document camera to show and explain their work when solving problems. Additionally, DL teachers used digital tools to help students visualize math concepts using models to connect the concepts with language and to support mathematical communication by explicitly teaching vocabulary and order of operations highlighting the grammatical structures of mathematics discourse.

Moreover, DL teachers use technology to assign independent work to their students. DL teachers use interactive digital tools such as game-based learning, educational videos, digital worksheets, and collaborative writing tools to help students reinforce concepts already taught and to apply new concepts (González-Carriedo & Esprívalo Harrell, 2018; Patthoff et al., 2021). In my qualitative pilot case study, the DL teacher assigned her students work on specific content area digital tools such as reading, math, and science applications, or language practice programs for targeting a particular content area. The participant used technology to differentiate instruction so that each student was able to engage with the content in a different way. Thus, DL teachers

can use technology tools to support students who might be struggling with certain concepts or skills.

Furthermore, DL teachers might use technology during instruction to engage all learners and check for student understanding through interactive digital tools such as student response systems and social media (Howard et al., 2018). Similarly, teachers can encourage students to show their learning of content in a variety of ways, such as visual representations, and voice recording using different digital tools (e.g., podcasts, videos, slideshows) in both program languages (Howard et al., 2018; Patthoff et al., 2021). Technology also enables teachers to integrate content as previously illustrated in the examples discussed of integrated biliteracy centers (Mercuri & Ramos, 2014). The researchers claimed that technology-based biliteracy centers facilitated both language acquisition and content knowledge. Next, I discuss how DL teachers can leverage technology to support the academic achievement of students with disabilities.

Supporting Students with Disabilities in DL. Research evidence does not justify excluding students with disabilities from DL programs (Genesee & Lindholm-Leary, 2013). However, some decisions on student inclusion need to be made on a case-by-case basis, especially with English-native speakers who have serious language processing disabilities (Howard et al., 2018). Genesee and Lindholm-Leary (2013) argued that students with learning disabilities are better served in DL because they acquire language skills in two languages, which enhances their future opportunities. In DL programs, students with learning disabilities can be supported with instruction that attends to students' learning styles and instruction that is embedded in culturally and linguistically relevant contexts (Martínez-Álvarez, 2017b).

Teachers can leverage technology to create more inclusive spaces in DL classrooms by using digital tools to enhance language and content learning. Martínez-Álvarez (2017b) explored how a technology-mediated place-based geoscience unit facilitated the learning of language and science for students with disabilities in fourth grade. The unit was about how water caused changes to the Earth's surface and included several activities. Based on what they had learned in class, students visited places in their community and took digital pictures of areas they found geomorphologically interesting. Next, they uploaded the pictures to an online discussion board and engaged in collaborative analysis of the pictures online. The teacher-researcher facilitated a discussion of related pictures (e.g., the Grand Canyon) and the text to scaffold for students. Place-based and technology-mediated activities enabled emergent bilinguals with disabilities to demonstrate science knowledge and understand grade-level science texts. In the next section, I discuss how DL teachers can leverage technology to support the development of sociocultural competence, which improves academic achievement.

Supporting Students' Sociocultural Competence

Curriculum in DL programs should include opportunities for students to develop sociocultural competence, i.e., multicultural appreciation, cross-cultural competence, and identity development (Howard et al., 2018). Teachers can support sociocultural development by helping students create positive self-images and positive images of others. DL teachers believe that technology can facilitate the integration of cultural components in the curriculum (Simonsson, 2004). For instance, DL teachers discussed using videos to showcase diverse cultures and listening to songs and stories about different traditions around the world (González-Carriedo & Esprívalo Harrell, 2018). Some strategies to develop sociocultural competence include honoring

students' funds of knowledge, fostering the development of a positive identity, and engaging students' families in school. Those strategies are discussed next.

Students' Funds of Knowledge. Because learning standards are not designed with emergent bilinguals in mind, adjustments are necessary when ensuring curriculum alignment with standards in DL programs (Howard et al., 2018). Such modifications should reflect the context of students' and their families' funds of knowledge. "Funds of knowledge are cultural and material resources that families and communities distribute among their members to solve problems they encounter in their everyday lives" (de la Piedra, 2010). Students' home linguistic practices such as reading religious texts, journaling, or translating for their parents can be applied in the classroom. The integration of students' funds of knowledge promotes a more inclusive and supportive learning community in class that fosters high academic achievement (García & Kleifgen, 2018).

Technology is an effective tool for incorporating students' funds of knowledge in the curriculum while improving students' academic achievement (De la Piedra, 2010; Martínez-Álvarez et al., 2012). For example, in a DL first grade class students were given digital cameras to photograph their families and communities to create digital comics while translanguaging (Martínez-Álvarez et al., 2012). A creativity rubric was used for pre- and post-assessment of students' writing samples in which they drew and wrote a story about their families. The rubric included measures of complexity, imagery richness, text richness, text amount, and feelings and emotions. The results showed that the students' creativity improved for at least four of the five components of the rubric. The amount of text was the most improved, F (1, 73) =11.46, $p< 0.01$, and richness of text, F (1, 73) = 4.07, $p< 0.05$, was the least impacted. Another study (de la Piedra, 2010) documented how a middle school DL teacher incorporated students' interests in

Mexican culture in class literacy activities such as reading, writing, and conducting research. An example of this was a project involving slide decks about students' favorite singers or bands. Students searched for sources online in both Spanish and English and created bilingual presentations. Students involved in the project wrote meaningful comprehensive texts and felt confident as skilled writers. When teachers incorporate students' funds of knowledge, they are assisting students with creating, expressing, and valuing their identities. This is further explained in the next section.

Supporting Students' Positive Identity Development. As identity is co-constructed through socio-linguistic interactions students in DL programs negotiate bilingual or multilingual identities while making sense of complex power dynamics in and outside of their classrooms (Hamman-Ortiz & Palmer, 2020). Students build their identities and understand the relationships among their different individualities such as second language learners, immigrants, members of their families, and citizens of their schools and community. Identity matters for school success, for instance, middle school students in DL programs have discussed how the different ways teachers allow or restrain their bilingual identities impact their learning and their sense of belonging (de Jong et al., 2020). Teachers can foster students' sense of belonging by encouraging student collaboration and building community through a culture of care.

Since our identities are stories we tell about ourselves, teachers should provide students with opportunities to author themselves (Pandya et al., 2015). Digital tools can enhance the storytelling and writing process (Martínez-Álvarez et al., 2012; Pandya, 2018). For instance, in a multimodal autobiography project, students told stories about themselves, their loved ones, or about family traditions or special events (Pandya et al., 2015). Students started writing using photographs they brought from home or by drawing pictures. These writings were used as video

scripts. An autobiographical assignment is a "classic positioning tool, as it forces students to choose a self to narrate" (p. 23). Most emergent bilinguals created multimodal compositions about who they were, their families, and their friends. One autobiography was centered on being a student in the school, which felt like home for that student. The digital videos afforded students many tools and methods to showcase their identities. According to the teachers, the project was quite successful as it enhanced students' writing skills and language acquisition. One teacher commented on how the multimodal composition process improved students' writing skills because after watching draft videos from their classmates, students added details to their written scripts. The project also increased students' confidence in both their English and Spanish language skills by providing a safe space for writing and speaking aloud. Additionally, focusing on family engagement is another way to honor students' funds of knowledge and contribute to the development of a positive identity; I discuss this next.

Family Engagement. Fostering family and community engagement is an important factor in effective DL programs. Family engagement is linked to higher academic achievement, higher language proficiency, higher graduation rates, higher enrollment in tertiary education, and better social skills (Howard et al., 2018). Moreover, parents of culturally and linguistically diverse students have high aspirations for their children and want to be involved in their schooling. Technology can be used to foster family and community engagement by enabling communication in both program languages and through a variety of channels.

Several applications are available to facilitate communication between family and school. In my qualitative pilot case study, I found that the DL teacher used applications that allowed her to send text messages to communicate with parents regularly. These applications have the capability of sharing pictures, so teachers can share pictures that showcase students' work or

special events in the school. Many of these applications have translation capabilities as well. The participant occasionally sent electronic newsletters to provide updates on what was happening in the classroom, what students were learning about, and reminders of important events. Moreover, the teacher sometimes used video-conferencing software to hold parent-teacher conferences. In the next section, I describe the LoTi framework as a lens to look at how DL teachers might use technology.

LoTi

Moersch (1997) argued that technology can be very powerful in education, but a shift was needed in the way technology was being integrated. He argued that the shift involved thinking of and applying technology tools as "data analysis centers, probeware stations, multimedia publishing outlets, and research kiosks to prompt students to think, reason, make informed decisions and communicate information based on the available data" (p. 52). To determine if technology is being used efficiently—that is, to support instruction and higher-order thinking skills (e.g., solving real-world problems, interpreting data)—Moersch developed a framework describing the different levels.

The LoTi framework consists of eight levels of technology efficiency, ranging from Level 0 (*non-use*) to Level 6 (*refinement*). As levels increase, instruction shifts from teacher-centered and practice-based to student-centered and problem-based (Moersch, 1997). Student-centered approaches are learning experiences in which student-generated questions guide part of the content, the process, or the product (LoTi Connection, 2016). In DL programs instruction is to be student-centered, thus instructional strategies should promote independence and ownership as well as peer collaboration (Howard et al., 2018). In lower levels of implementation, the teacher mostly uses technology to supplement or expand instruction (e.g., tutorials, games)

(Moersch, 1997). In higher levels of implementation, technology is used as a tool to identify and solve real-world problems related to an overall concept and extend learning outside of the classroom (e.g., collaborating with experts or organizations). DL teachers have discussed not being comfortable with technology integration that requires students to apply higher-order thinking skills (González-Carriedo & Esprívalo Harrell, 2018). Table 1 lists and describes each of the LoTi levels with examples of each level in DL contexts.

Table 1

The LoTi Framework Levels with Examples for Dual Language (DL)

LoTi Level	Description	DL example
0: Nonuse	No technology use or learning experience is not standards-based.	Students do not use digital technologies or play non-educational games.
1: Awareness	The teacher uses technology to enhance her lesson delivery.	The teacher uses a digital whiteboard to show images or videos to support language acquisition.
2: Exploration	Students use technology to gather information or for extension activities.	Students use the internet to research influential figures.
3: Infusion	Students use technology for complex tasks such as problem-solving or decision-making.	Students work in groups to translate text using digital translators but focus on the proper translation of meaning.
4a: Mechanical Integration	The learning experience is student-centered with real-world application, but contextual factors restrict full integration.	Students create multimodal compositions responding to a teacher-given prompt.
4b: Routine Integration	Students are engaged in self-directed and problem-based learning.	Students regularly create multimodal compositions on topics generated by them that are problem-based such as school or community issues.
5: Expansion	Students collaborate with experts outside of the classroom and create authentic products that solve student-centered problems.	Students collaborate with scientists via telecommunication or email to solve a pollution problem in their community and create slide decks to present possible solutions.
6: Refinement	As Level 5, but products are innovative and created using unconventional strategies.	Students collaborate with scientists via telecommunication or email to solve a pollution problem in their community and create multimodal compositions that include translanguaging and a recording or video of an interview with the expert. Students publish their products.

Note. LoTi = level of technology integration

Because the LoTi framework emphasizes the degree to which technology is used to support a constructivist pedagogical approach (Moersch, 1997), it has been applied along with other technology models such as TPACK and Substitution, Augmentation, Modification, and Redefinition (SAMR; Bataller, 2018; Terra, 2019) to other studies examining teachers' use of technology. For instance, a study identifying and describing the best technology integration practices by expert middle school teachers and their challenges employed the LoTi framework, the SAMR model, and the International Society for Technology in Education (ISTE) standards as foundational underpinnings (Bataller, 2018). A similar study focused on award-winning teachers' best educational technology practices was framed by the LoTi framework and the SAMR model (Terra, 2019). In this study, I employ the LoTi framework as a lens for analyzing DL teacher's technology use because DL teachers should be facilitators of learning and implement student-centered instructional strategies (Howard et al., 2018).

DL teachers can leverage technology to support their students' bilingualism, biliteracy, academic achievement, and sociocultural competence, however, due to different factors such as time constraints and ineffective professional development, teachers' level of technology implementation differs and is not always efficient (Harris et al., 2009; Moersch, 1997). In the next section, I describe the factors that might influence DL teachers' use of technology by applying Biesta's et al. (2015) teacher agency framework.

Factors Influencing DL Teachers' Use of Technology

DL teachers' use of technology is related to their beliefs and attitudes about technology and contextual factors (e.g., school supports), which influence teachers' decision-making (González-Carriedo & Esprívalo Harrell, 2018). As DL teachers make instructional decisions about what resources to use for planning, what instructional strategies to apply, and what digital

tools to use; they exercise their agency, making active contributions to their work and their environment (Biesta et al., 2015).

Teacher Agency

Agency "denotes a quality of the engagement of actors with temporal-relational contexts-for-actions" (Biesta et al., 2015, p. 626). Therefore, agency emerges from the individuals' interactions with their context. Teacher agency emerges from three dimensions: *iterational*, *practical-evaluative,* and *projective*. All three dimensions interplay in teachers' enactment of agency, however, the degree to which each one is activated in a particular situation might vary.

The Iterational Dimension. The iterational dimension is shaped by past experiences including teachers' personal and professional stories (Biesta et al., 2015). These experiences have built patterns of thoughts and actions that often get reactivated and are reflected in the teachers' beliefs, values, and their educational philosophy. In the qualitative pilot case study I conducted, I found that due to technology's ubiquity, the DL teacher believed that integrating technology in her instruction was part of her job as a teacher. She expressed being so accustomed to using certain technologies such as the digital whiteboard and the document camera, that she could not imagine teaching without them. She perceived technology-based learning experiences as engaging and motivating for her students. Other studies have shown that DL teachers believe technology is engaging for their students (González-Carriedo & Esprívalo Harrell, 2018; Patthoff et al., 2021; Simonsson, 2004).

DL teachers discussed technology as a useful tool by identifying advantages such as accessing information, streamlining daily activities, and networking (González-Carriedo & Esprívalo Harrell, 2018). They agreed that technology fostered student collaboration and improved students' mastery of content and enhanced second language acquisition. Additionally,

the DL teachers reported that applications targeting language acquisition allowed students to practice the language in a safe environment—that is, without the pressure of talking in front of the whole class (González-Carriedo & Esprívalo Harrell, 2018; Patthoff et al., 2021). Teachers also stated that technology was helpful when working with students from minority backgrounds because it facilitated the integration of culture into the curriculum (Simonsson, 2004).

The Practical-Evaluative Dimension. The second dimension of teacher agency, practical-evaluative, encompasses teachers' engagement with the present (Biesta et al., 2015). Current contextual demands or situations affect teachers' decision-making, as their decisions are influenced by their school or district culture and organizational structures, and their material context (e.g., resources and physical environment). DL teachers make decisions in response to diverse demands such as DL implementation, district and school requirements, and students' needs. The DL teacher who participated in my qualitative pilot study mentioned that integrating technology was a district expectation. During remote teaching, her district had invested in a one-to-one program that provided every student with a laptop, and even when resuming in-person learning, students were expected to use their digital devices for several hours during the instructional day. The district mandated that students engage with reading and math intervention software for a certain number of minutes (about 30 minutes each) daily. Furthermore, the DL teacher stated that her use of technology was limited by planning and instructional time constraints and a lack of resources in Spanish. Other studies have documented similar findings (González-Carriedo & Esprívalo Harrell, 2018). Specifically, the participants identified the lack of instructional time due to school or district demands as a barrier to effective technology integration. DL teachers explained that the limited instructional time was exacerbated during state testing time when less instructional time was available.

Furthermore, DL teachers frequently receive inadequate professional development for technology integration. Patthoff et al. (2021) stated that a majority of DL teachers used technology for rote math practice and surface-level engagement (e.g., catchy songs and games) because teachers did not have regular professional development on how to use technology for higher-order thinking. Additionally, DL teachers stated that district training was designed for general education teachers and not specially designed for DL (González-Carriedo & Esprívalo Harrell, 2018). Spanish DL teachers criticized the professional development sessions because they were focused on digital tools for teaching in English only. The DL teacher in my qualitative pilot study had a similar experience. However, she was able to receive support from her grade-level colleagues and the instructional technology coach. With their support, she was able to use digital tools to create activities for her students to practice the content previously taught. Although she enjoyed the creative process, it was time-consuming, and she did not have enough planning time to create technology-based activities frequently.

The Projective Dimension. The third dimension of teacher agency is the projective one, which represents teachers' inclinations toward the future (Biesta et al., 2015). These possible future courses of action can be short or long-term and are framed by the teachers' concerns and aspirations for their students or their professional goals. Data from the qualitative pilot study I conducted showed that the DL teacher had short- and long-term goals for her students. She wanted her students to be successful in school, but she also wanted to provide them with skills that would prepare them for their future. The DL teacher stated that her students needed to develop technological skills if they were to succeed academically in future grade levels and afterward when furthering their education or entering the workforce. Another study showed the same results as DL teachers expressed that students needed technology skills to be prepared for

their future and to become productive members of society (González-Carriedo & Esprívalo Harrell, 2018).

Summary

By promoting bilingualism, biliteracy, academic achievement, and sociocultural competence, DL programs benefit all participating students (Howard et al., 2018). DL programs have the potential of fully closing the achievement gap for emergent bilinguals (Thomas & Collier, 2012). Since DL programs emphasize teaching language through content, teachers who are part of these programs require a unique set of skills acquired from different types of knowledge: content, pedagogical, technological, and language. Those types of knowledge are encompassed in the TPACK (Mishra & Koehler, 2006) and PLK (Bunch, 2013) frameworks.

By applying TPACK and PLK, DL teachers can use technology to support the goals of DL. DL teachers mgiht use technology to foster and promote language development in the four language domains, listening, speaking, reading, and writing, as well as metalinguistic awareness through integrated biliteracy centers, multimodality, and translanguaging. DL teachers can leverage technology to improve academic achievement by incorporating relevant curriculum resources such as images, videos, and virtual field trips. DL teachers might assign technology-based activities, tailored to the student's proficiency level, to reinforce previously taught concepts or apply new knowledge. Further, DL teachers can use technology to check for student understanding and to support the learning experiences of students with disabilities. To address the sociocultural competence goal, DL teachers might use technology to incorporate students' funds of knowledge in the curriculum, foster the development of positive student identity, and engage students' families in their schooling.

While the meaningful use of technology can enhance students' learning experiences, DL teachers' use of technology is conditioned by different factors that influence their decision-making (Biesta et al., 2015) and their level of technology implementation (Moersch, 1997). DL teachers who have positive dispositions about technology are likely to use technology more frequently (González-Carriedo & Esprívalo Harrell, 2018). Contextual factors like school or district mandates, time constraints, and inadequate professional development also influence DL teachers' use of technology. Moreover, DL teachers' future goals for their students or own professional goals affect the way they use technology, for instance, DL teachers might integrate technology because they believe their students need technology skills to be ready for college or their careers (González-Carriedo & Esprívalo Harrell, 2018). All these factors also influence the approaches DL teachers take when using technology, approaches can be teacher-centered and practice-based or student-centered and problem-based (Moersch, 1997).

CHAPTER 3

METHODS

The purpose of this study was to explain how and why dual language (DL) teachers use technology. As described in Chapters 1 and 2, only a limited number of studies have been conducted investigating teachers' technology use in DL programs. In this chapter, I discuss in detail the methods and procedures I used to conduct this study. I describe the research design and the conceptual framework which informs the methods, the population, and the procedures for each strand of this mixed methods study. I explain the data sources and methods for data generation and data analysis for the quantitative and qualitative phase. Moreover, I review the delimitations, limitations, and assumptions of this study. Lastly, I present a researcher as instrument statement and discuss the ethical considerations for this study.

In this study, I aimed to answer the following questions:

- Overall R.Q.: How and why do DL teachers use technology?
- Quantitative R.Q.1: In what ways do DL teachers use technology?
    - 1a: In what ways do DL teachers use technology for planning?
    - 1b: In what ways do DL teachers use technology for instruction?
    - 1c: In what ways do DL teachers use technology for assessment?
    - 1d: In what other ways do DL teachers use technology?
- Quantitative R.Q.2: What factors influence teachers' use of technology?
- Qualitative R.Q.1: How do DL teachers describe their decision-making when using technology?

- Qualitative R.Q.2: To what extent do DL teachers use technology to support the goals of DL?

Research Design

This study employed a mixed methods design, which is an approach for collecting, analyzing, and integrating both quantitative and qualitative data, with the assumption of gaining additional insights from the data integration (Creswell & Creswell, 2018). Mixed methods research is characterized by *methodological eclecticism*, or "selecting and then synergistically integrating the most appropriate techniques from a myriad of [qualitative], [quantitative], and mixed methods to more thoroughly investigate a phenomenon of interest" (Tashakkori & Teddlie, 2010, p. 8). A mixed methods research design provides the opportunity to offset the weaknesses of quantitative methods with the strengths of qualitative methods, and vice versa (Creswell & Plano Clark, 2017).

In quantitative research, an investigator uses a postpositivist lens to develop knowledge (Creswell & Creswell, 2018). Quantitative research involves testing objective theories by examining the relationship among variables. These variables are typically measured using reliable and validated instruments. The numerical data generated is analyzed statistically. In this approach, researchers set up procedures against bias and are usually able to generalize and replicate findings. On the other hand, in qualitative research, an investigator employs a constructivist or transformative lens to develop knowledge (Creswell & Creswell, 2018). Qualitative research involves exploring or seeking to understand a social problem from an individual or group's perspective. The process usually involves collecting data in the participants' natural setting and analyzing the data inductively from specific to overall themes or patterns. The researcher also interprets the meaning of the data results.

In a mixed methods approach, the researcher builds knowledge on pragmatic claims (Creswell & Creswell, 2018). Pragmatism draws on "employing what works, and valuing both objective and subjective knowledge" (Creswell & Plano Clark, 2017, p. 44). Mixed methods research involves choosing the approaches and data collection methods that are most appropriate for answering the research questions. Under pragmatism, quantitative and qualitative methods are seen as compatible, thus, both types of data are collected sequentially or concurrently to better understand the research problem (Tashakkori & Teddlie, 2010). Researchers who employ a pragmatic paradigm focus on the problem and choose methods and data sources that best answer the research questions (Creswell & Creswell, 2018). Pragmatic researchers also emphasize the practical implications of the research. By employing a mixed method approach I was able to involve participants in the study at different stages to understand nuances, conduct member checking, and consider meaningful application of findings (Creswell & Plano Clark, 2017).

When designing a mixed methods study, a researcher needs to choose from one of the multiple mixed-methods research designs (Creswell & Plano Clark, 2017). Over 40 mixed-methods research designs have been reported in the literature (Tashakkori & Teddlie, 2010). Creswell and Plano Clark (2017) focused on three core mixed methods designs: explanatory sequential design, exploratory sequential design, and convergent design. The first word in the label of the design refers to the purpose of the design (i.e., to explain, to explore, to converge), while the second word in the label (i.e., sequential, convergent) refers to the order of the quantitative and qualitative components. Choosing the most appropriate design requires consideration of the importance or priority given to the quantitative and qualitative data

collection and analysis, the sequence of the data collection and analysis, and the stages at which the quantitative and qualitative components are integrated (Ivankova et al., 2006).

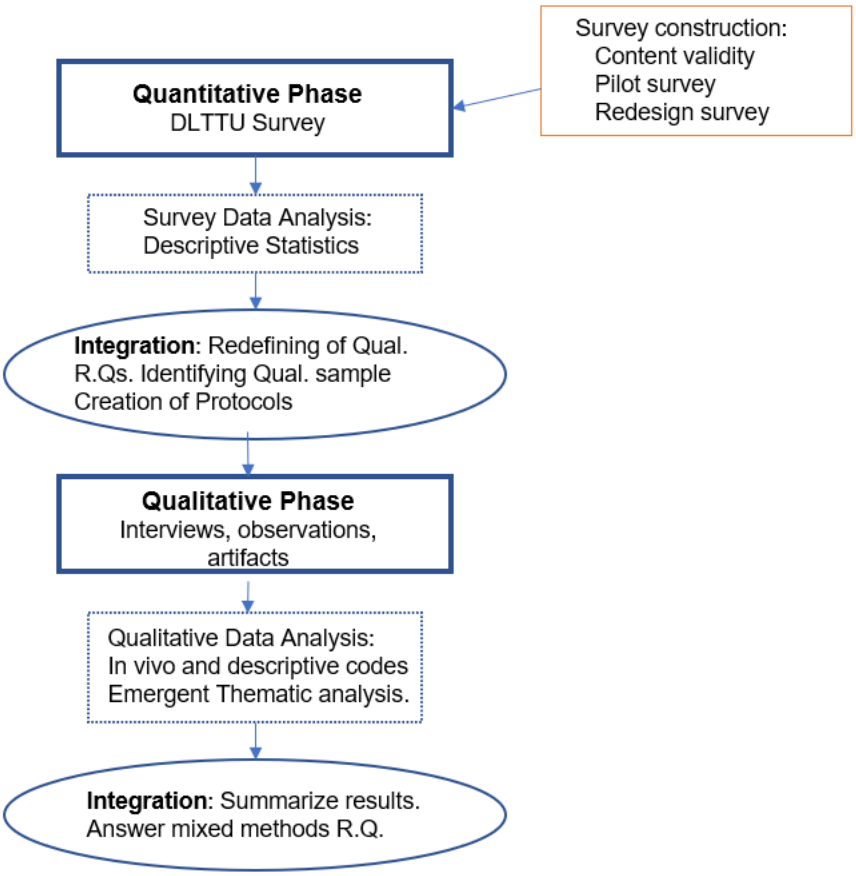
For this study, I employed an explanatory sequential mixed method design, which has two phases or strands: quantitative followed by qualitative (Creswell & Plano Clark, 2017). In this design, the researcher first collects and analyzes quantitative data; then the researcher gathers and analyzes qualitative data to further explain or expand on specific quantitative results from the first phase (Ivankova et al., 2006). The rationale behind an explanatory sequential mixed methods design is that the quantitative strand provides a general understanding of the research problem. The qualitative strand further explains the quantitative results by exploring selected participants' perspectives in more detail (Creswell & Guetterman, 2018; Ivankova et al., 2006). I chose this design because it was the best fit for the purpose of the study and the best fit for answering the research questions. This design allowed me to combine a quantitative phase addressing the *what* using a large sample with a qualitative phase with a smaller sample explaining the *why* (Creswell & Creswell, 2018).

Explanatory Sequential Mixed Method Design Process

An explanatory sequential mixed method design follows a four-step process (Creswell & Plano Clark, 2017). The first step is the quantitative phase. The second step is the integration of quantitative and qualitative phases. In this integration, quantitative results are used to refine the qualitative phase. The third step is starting the qualitative phase which leads into the fourth step: the integration of both quantitative and qualitative results to answer the mixed methods research question. The process for this explanatory sequential mixed method study is illustrated in Figure 2. The quantitative and qualitative phases are represented in dark blue rectangles, while the two integration steps are represented with blue ovals.

Figure 2

Explanatory Sequential Design Process



Note. DLTTU= dual language teacher technology use. R.Q.= research question

First, I collected quantitative data with a web-based original survey. Data analysis consisted of descriptive statistics. The goal of the quantitative phase was to describe the different ways DL teachers use technology and the factors that influence their use. Another goal of this phase was the purposeful selection of the sample for the qualitative phase based on the quantitative results identified as needing further exploration. Before the qualitative phase began, I refined the qualitative research questions and adjusted the data generation protocols (i.e.,

interview protocols) as needed based on the quantitative results. I added the first question about how technology can be an effective tool and reworded the second question since all participants had indicated that technology was useful for supporting the goals of DL.

In this mixed methods study, the qualitative strand was a major component because I spent more time and effort collecting and analyzing qualitative data. I generated data through individual semi-structured interviews, classroom observations, and artifacts (i.e., pictures of participants' slide decks and students' work samples) to explain how some of the ways teachers use technology help support the goals of DL. Another aim of this phase was to explore DL teachers' decision-making process when using technology.

By following the process of an explanatory sequential mixed methods design, I was able to determine how a large number of DL teachers use technology and what factors influence their use of technology. Meanwhile, the qualitative strand helped me to further explain the quantitative results by exploring participants' practices with technology in their classrooms and their reasoning for such practices. In the next section, I describe how the conceptual framework guided the methods of this study.

Conceptual Framework for Methods

As discussed in Chapters 1 and 2, this study is grounded in Mishra and Koehler's (2006) technological pedagogical content knowledge (TPACK) framework, Bunch's (2013) pedagogical language knowledge (PLK), Biesta's et al. (2015) teacher agency framework, and Moersch's (1997) levels of technology implementation (LoTi) framework. I used TPACK (Mishra & Koehler, 2006) and PLK (Bunch, 2013), as a lens when I analyzed DL teachers' decision-making when using technology. I considered how DL teachers' content, pedagogical, technological knowledge as well and PLK influenced teachers' decision-making and technology use.

I applied the teacher agency framework created by Biesta and colleagues (2015) to analyze the factors that might influence teachers' use of technology. Teachers' enactment of agency is influenced by their personal and professional experiences including their beliefs (iterational), their future goals (projective), and the contextual factors of their working environment (practical-evaluative). Additionally, I used the LoTi framework (Moersch, 1997) as a lens when I analyzed the ways DL teachers used technology. The LoTi framework focuses on technology implementation efficiency and consists of eight levels of technology efficiency, ranging from Level 0 (*non-use*) to Level 6 (*refinement*). As levels increase, instruction shifts from teacher-centered and practice-based to student-centered and problem-based. In DL programs, teachers should employ a student-centered approach by promoting independence, ownership, and peer collaboration (Howard et al., 2018). Thus, higher LoTi levels indicate better alignment with the goals of DL.

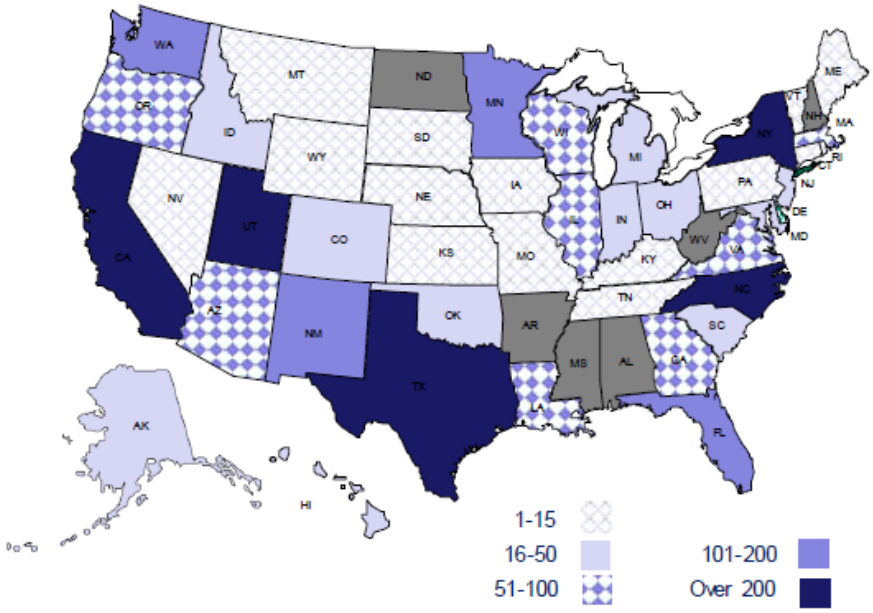
Participants

Criteria for selecting the participants for this study included: (a) DL teachers from one-way or two-way DL programs; (b) DL teachers from public schools, charter schools, and private schools; (c) DL teachers teaching in PreK-12 Grades in the 2022-2023 academic year. Although the current number of DL teachers is unknown, it can be estimated based on information on the number of DL programs across the United States. Data collected in the fall of the 2021-2022 school year indicated that there were about 3,650 DL programs across the country (American Councils Research Center, 2021). Forty-four states report hosting DL programs. The most taught partner languages are Spanish (about 80%), Chinese (about 9%), and French (5%). Based on the number of programs reported in Fall 2021 and considering that some programs might have self-contained or team teachers, I can estimate that the total number of DL teachers is in the 32,850-

43,800 range. Figure 3 shows the distribution of DL programs across the United States. Most DL programs (60%) are located in California, Texas, New York, Utah, and North Carolina.

Figure 3

Dual Language Programs Distribution in 2021



Note. From 2021 *Canvass of Dual Language and Immersion (DLI) Programs in U.S. Public Schools*, by American Councils Research Center, 2021 (https://www.americancouncils.org/sites/default/files/documents/pages/2021-10/Canvass%20DLI%20-%20October%202021-2_ac.pdf). In the public domain.

For the quantitative phase, I employed a convenience and snowball sampling method to recruit participants (Creswell & Guetterman, 2018). After IRB approval was obtained, I used my professional network of DL educators to find participants. I contacted DL educators via email and requested that they extend the invitation to the teachers in their program. In addition, I distributed the survey via social media (e.g., Facebook) to DL teachers' interest groups. These groups are private; a person has to require permission to join usually by answering some filtering

questions. These groups are also monitored by moderators and they include *Spanish immersion & DL teachers* established in 2016 with approximately 8,300 members; *NABE DL learning* established in 2020 with approximately 4,100 members; and *Bilingual teachers/Dual language* established in 2018 with approximately 55,200 members. In the social media groups, I posted a brief invitation to participate in the study including a link to the survey in Qualtrics. See Appendix A for email and social media recruitment letters. My goal was to obtain 250-300 participants for the quantitative phase of the study.

For the qualitative phase, I employed purposeful sampling (Creswell & Guetterman, 2018) by intentionally selecting individuals who could best answer the follow-up questions that arose from the quantitative data analysis (Creswell & Plano Clark, 2017). For instance, from the quantitative data analysis, I found two different groups of teachers, one implementing technology with a student-centered approach and one with a teacher-centered approach. I selected participants from each group to obtain more in-depth information about why these groups differ, and what supports they have or lack. I selected participants who were deemed as the best fit for providing further explanation and those who had already given permission in the survey to be contacted for a follow-up. I decided to select a small number of participants (n = 5) to obtain rich and deep data regarding DL teachers' use of technology.

Quantitative Phase

Once I received approval from the institutional review board (IRB), I started data collection by distributing an online survey. Next, I provide details on the data sources that were employed in this phase as well as a description of the data collection and data analysis.

Data Sources

To answer the research questions in the quantitative phase, I developed and piloted an original survey. After reviewing existing surveys measuring technology integration, I found that most of the other surveys were outdated or focused on teachers' perceptions and attitudes toward technology. Only two extant surveys, the Teacher Technology Integration Survey (TTIS) (Vannatta & Banister, 2009) and the Levels of Technology Implementation (LoTi) (LoTi Connection, 2016) include a few items aligned with my research questions.

The TTIS measures teachers' perceptions of technology, teachers' technology use, and students' technology use (Vannatta & Banister, 2009). Factors measured in the TTIS include Risk-taking Behaviors and Comfort with Technology; Perceived Benefits of Classroom Technology Use; Beliefs and Behaviors about Classroom Technology Use; Technology Support and Access; Teacher Technology Use for Administration and Instruction; Teacher Technology Use for Communication; Student General use of Technology; and Student Use of Specific Software/Tools. The other survey I referenced, the LoTi, was created to measure teachers' level of technology implementation (Moersch, 1997). Different versions of the LoTi exist, including the LoTi Digital Age Survey for Teachers, meant to measure teachers' professional priorities related to technology implementation (LoTi Connection, 2016). The factors included in the survey are Academic Experience, Digital Landscape, Teacher Perceptions, Program Support, Use of Resources, and Classroom Practices (LoTi Connection, 2017). I adapted eight items from each of these two surveys and incorporated them into the survey I created (see Appendix B for a list of survey items and their sources).

Nevertheless, no extant survey takes into consideration the unique features of DL instruction, therefore, I developed an original survey that accounts for this specific context. This

survey is called the Dual Language Teachers' Use of Technology Survey (DLTUTS). Items included in the DLTUTS were also adapted from other sources. In the next section, I describe these sources and the process for creating the survey.

Instrument Development. Based on an extensive literature review and the qualitative pilot study I conducted, in the first version of the DLTUTS, I hypothesized three categories, *DL teachers' use of technology, factors that influence teachers' use of technology*, and *students' use of technology*. I used different sources for the items I created including findings from the qualitative pilot study I conducted in the Spring of 2022, the TTIS and the LoTi surveys, recommendations from the *Guiding Principles for Dual Language Education* (Howard et al., 2018), and competencies listed in the ISTE (n.d.) educators' standards. The ISTE standards guide teachers to integrate technology in innovative ways by taking a student-centered approach. The first version of the DLTUTS consisted of 93 Likert-type items written as declarative statements measuring the three categories. Participants were to respond to each of the items by indicating the extent to which they agree with the statement in a 5-point Likert-type response format ranging from *Strongly Disagree* (1) to *Strongly Agree* (5).

Reliability and Validity

In quantitative research, the reliability and validity of an instrument are key to decreasing measurement errors that might arise in the research study (Creswell & Guetterman, 2018). An instrument must report individual scores that are stable and consistent. Therefore, I consulted with an expert panel consisting of two DL teachers and two technology integration coaches to validate the contents of the DLTUTS. Experts provided feedback on how relevant the items were considering the research questions of the quantitative phase of this study. Experts' feedback included comments on items' relevancy, redundancy, or wording. I made revisions based on the

experts' comments. I reworded or eliminated some items, consolidated items, and categories, and added new items. After the revisions, the second version of the survey consisted of 63 items measuring two categories *DL teachers' use of technology* and *factors that influence teachers' use of technology.* The third hypothesized category, *students' use of technology* was eliminated, however, the items marked as relevant were embedded in the *DL teachers' use of technology* category in the instruction and assessment subscales.

I then requested approval from the IRB to pilot-test the survey with three DL teachers that met the participant criteria. The goal of the pilot study was to validate the instrument and test its reliability (Creswell & Guetterman, 2018). The pilot consisted of cognitive interviewing which entails the participants verbalizing their thoughts and feelings as they read and answer a questionnaire (Shafer & Lohse, 2005). The cognitive interviews were video recorded. The three participants were given a link to the survey to complete. As they took the survey, participants commented on the relevancy of some items, the lack of clarity of some items, and the appropriateness of the scales used for response choices. When participants finished completing the survey, they were asked if they had further suggestions for survey improvement. This process provided me with insights into participants' perceptions of the survey items. Piloting the survey contributed to establishing the reliability, face, and content validity of the survey (Creswell & Guetterman, 2018).

I made more revisions to the DLTUTS based on the pilot test, including changing the section for the *DL teachers' use of technology* category from a Likert-type scale to a frequency scale. The final version of the survey includes 47 items measuring two categories: *DL teachers' use of technology* and *factors that influence teachers' use of technology* (see Appendix B for a list of the 47 items including their source). The first section of the survey contains items

regarding the *factors that influence teachers' use of technology* (e.g., it is mandatory in my school/district that I use certain digital tools). This section includes two subsections: contributing factors and inhibiting factors. In this section, participants indicate their level of agreement with a 5-point Likert-type response format ranging from *Strongly Disagree* (1) to *Strongly Agree* (5). The second section of the questionnaire consists of items related to the category *DL teachers' use of technology* and is divided into four subscales: technology use for planning, technology use for instruction, technology use for assessment, and other technology use. In this section participants answer by choosing a level of frequency from a 5-point frequency scale *Never* (1) to *Very Frequently* (5). Table 2 shows a sample item for each survey subsection.

Table 2

DLTUTS Survey Sample Items and their Sources

Subsection	Item	Text	Source
Contributing Factors	1	Teaching students how to use technology is part of my job.	TTIS
Inhibiting Factors	11	One of my challenges for technology integration is the lack of planning time.	LoTi
Planning	20	I use the internet/social media to learn new teaching strategies.	Qual. pilot study
Instruction	26	I use technology to provide diverse and current curriculum resources (e.g., photos, videos, virtual field trips, and primary source materials) in the language I teach.	DL guiding principles
Assessment	36	I use student-centered performance assessments that involve students transferring what they have learned to a real-world context using diverse digital tools.	LoTi
Other Uses	44	I use applications to send families tips/resources for supporting their children's language development.	DL guiding principles

Note. DLTTUS= dual language teacher technology use survey; TTIS= teacher technology integration survey; LoTi= levels of technology integration; DL= dual language.

Additionally, the survey includes a consent page at the beginning, a third section with seven demographic questions, and a request to recruit participants for the qualitative phase. The demographics section includes questions such as the participants' years of teaching experience overall and in DL, their teaching role (e.g., teaching in English, in the target language, or self-contained), and their grade level. Appendix C includes the complete survey in Qualtrics.

Data Collection

After I obtained IRB approval, I deployed the DLTUTS for data collection. Participants were recruited at the same time the survey was distributed. The first page of the survey includes a consent form (see Appendix D) in which prospective participants can accept or decline participation in the study. The survey was built in Qualtrics and a link to it was distributed electronically via email and through social media.

Data Analysis

To answer the research questions, I conducted a statistical analysis using IBM SPSS 27. Descriptive statistics were used to explore the different ways DL teachers used technology. I employed the transfer data function from Qualtrics to upload the data to SPSS. First, I cleaned the raw data (e.g., assign names to variables, code data, and manage missing data). Next, I ran descriptive statistics, including mean, standard deviation, and frequencies. I summarized descriptive statistics for the survey items and reported them in tables. I also described my participants by reporting on their demographics, for example, their years of teaching experience, their grade level, and their language of instruction. I conducted a frequency analysis to identify the percentages for the different ways in which DL teachers use technology. As suggested by Creswell and Plano Clark (2017), during the analysis I also noted what statistical results were worthy of further exploration and I identified participants for the qualitative strand.

Qualitative Phase

Once the quantitative data analysis was completed, I began the qualitative phase by first deciding what specific results needed further explanation. I was interested in knowing why teachers used certain digital tools, and how DL teachers' technology use in the classroom aligned with the goals of DL. In the next sections, I describe the qualitative data generation, data sources, data analysis, and my plan for establishing credibility.

Data Generation

After I completed the quantitative data analysis, I identified five DL teachers to participate in the qualitative phase of this study. I selected participants based on their survey responses and their willingness to be part of the qualitative phase of this study. I also had to consider my ability to complete observations in the participants' classrooms in a timely manner. I selected the five participants purposefully to capture different levels of technology use (from teacher-directed and practice-based to student-centered and problem-solving approaches) and a wide range of examples of technology use at different grade levels. I contacted the prospective participants by email to confirm participation in the second phase of the study (see Appendix E). The email provided a summary of the purpose of the study and explained the process for the second part of the study. I sought permission from school districts where participants taught to conduct the classroom observations by following their established procedures. Appendix F contains the letter that I sent to the school district's research compliance administrator. Once permission was obtained, participants were provided a second consent form (see Appendix G). Then, I scheduled interviews and observations at the participants' convenience.

Data Sources

I generated data using three different sources: semi-structured interviews, observations, and artifacts. I started with an interview, then I conducted observations and collected artifacts, and I finished with a second interview. Interviews were one-on-one and took about 45 minutes. The semi-structured interviews included questions already created before the interview, but there was also room for probing or follow-up questions according to the responses (Turner, 2010). I selected semi-structured interviews because they allow for flexibility in eliciting information from the participants. I gave participants the option to be interviewed in person or via Zoom and they all preferred to be interviewed via Zoom. The first interview sought an additional explanation of the participants' survey responses, while the second interview was a follow-up to the observations to understand the teachers' decision-making process. Appendices H and I include the interview protocols I used. I created some questions for the first interview, but these questions were adjusted based on the quantitative results. Similarly, I developed some questions for the second interview, but these were revised based on the observations. All interviews were recorded.

Observations were another data source, consisting of two 90-minute classroom observations to explore the DL teachers' use of technology. Observations focused on instruction and planning practices. I video-recorded the observations and took field notes. Since the focus of this study is on teachers, and to preserve students' identities, the camera was directed at the teacher participants. I used an observation protocol (see Appendix J) to record descriptive and reflective field notes (Creswell & Guetterman, 2018). During observations, I focused on moments or events that answered the research questions. Additionally, I used the video recordings to check my field notes in case relevant instances were missed. My position during

observations was a participant observer role (Creswell, 2013). I observed the events taking place, but in some instances, I was also involved in what was happening. For example, there were a couple of times when I assisted a teacher with the interactive whiteboard or students by reminding them of their teacher's instructions.

During my visits to the classrooms for observations, I also collected artifacts. These were pictures of students' screen devices showing examples of technology-based learning activities, copies of students' work samples illustrating projects assigned by their teacher, or formative assessments. The artifacts also included pictures of the teachers' digital whiteboards showing examples of how the teacher provided instruction using technology and the type of activities the class engaged in using digital tools. The artifacts collected served as illustrations of what was observed in the classrooms.

Data Analysis

The data generation and analysis process were iterative (Creswell & Plano Clark, 2017). After conducting the first interviews, I explored the data to gain a general understanding of it. I followed the same process after the observations so that if any question arose, I could address it in the second interview. Once data generation was complete, I followed Creswell's (2013) recommendations for analyzing qualitative data: organizing the data; reading fieldnotes and writing margin notes to identify codes; describing the case and the context; using codes to identify patterns or themes; and interpreting patterns or themes. Once data was organized digitally, I engaged in "complex reasoning through inductive and deductive logic" while analyzing the qualitative data (Creswell, 2013, p. 45). First, I analyzed the data inductively by using descriptive and in vivo codes (Saldaña, 2014) and building patterns or themes. Second, I analyzed the data deductively by checking the data against the assigned codes and themes

already built while also considering the conceptual framework that guided this study. I started by analyzing the first interview transcripts, then the observations, and finally the second interview transcripts. When analyzing observations, I first reviewed the video recordings and compared them to my field notes. Any missed relevant instances were added to the field notes. The field notes were coded similarly to the process followed with the interview transcripts, applying codes already established and adding new ones as needed. After the observation analysis, I revised the second interview protocols to allow for follow-up questions that arose during the observations. Since artifacts only served as examples of the different ways DL teachers used technology, it was not necessary to analyze them.

During the data analysis process, I used member checks to ensure the accuracy of interpretation by sharing a summary of the preliminary findings with the participants from the qualitative phase on two different occasions. The first member check occurred after I transcribed the first interview. I summarized the transcript and asked the participants to check for accuracy. The second member check occurred after data collection was completed. I sent a summary of preliminary findings to participants and asked them to check for accuracy. I also engaged in analytic memoing to document my reflections about the data and my thinking process (Miles et al., 2020). Memos were starting points for drawing conclusions and report writing.

Finally, I created a network to display the condensed data and show the relationship between codes and themes using the study's conceptual framework as a lens. This visual display (see Appendix K) assisted me with theme creation and data interpretation. I used the display as a frame to create a storyline to answer the research questions of this phase.

Establishing Credibility

Creswell and Creswell (2018) recommended different strategies to ensure validation in qualitative research. The authors suggested that a researcher apply at least two of these strategies. I employed 4 of the 8 strategies recommended:

- Triangulation refers to the use of different data sources for studying the same phenomenon. I corroborated codes and themes through different data sources (interview audio recordings and transcripts, observation field notes and video recordings, and artifacts).
- Rich and thick description means providing a detailed description of the phenomenon. I used various data sources to capture and provide a detailed picture of the phenomenon studied.
- Member checking refers to sending the data results to the participants to check for accuracy. I obtained feedback from the participants to corroborate the correctness of the preliminary findings.
- Clarifying researcher bias means describing the researcher's past experiences as they relate to the phenomenon studied and considering them to avoid influencing the results of the study. I explained my professional background and previous experiences as a DL teacher and using technology in a "researcher as instrument statement."

Moreover, video recording added a layer of rigor to the observations because before analyzing the field notes I was able to review the recordings first and take notes of any important instance that I missed. Also, to ensure dependability I made "as many steps as operational as possible" (Yin, 2009, p. 45) by following a systematic process for data collection and analysis

documenting each step of the process. Explaining this process in detail ensures replicability by another researcher.

Delimitations, Limitations, Assumptions

In this section, I describe the boundaries that I have set for the study and the limitations that might affect the results of this study. I also explain my assumptions about DL teachers' use of technology.

Delimitations

This study focused solely on Prek-12th-grade DL teachers in the United States teaching in the 2022-2023 current school year. Additionally, the study was confined to the school sites where the participants of the second phase of the study teach. My participants for the qualitative phase were DL teachers from school districts in the eastern region area. These school districts host DL programs as a strand within a school; that is, only a few classes per grade level are part of the DL program.

Limitations

One of the limitations of this study is the convenience snowball sampling method that was used in the quantitative phase of the study. Participants were recruited via email and social media groups. Participants were also asked to share the survey with their colleagues who also met the participant criteria. I counteracted sampling error by employing a large sample so that different participants' views were represented (Creswell & Guetterman, 2018). Another limitation is that in the quantitative phase of this study, I collected data using a self-report survey and self-responses might be biased (Creswell & Creswell, 2018). Furthermore, due to the interpretative nature of qualitative research, I might introduce my own bias into the research. I hope that by engaging in reflexivity I can reduce this limitation. Additionally, the geographical

location of school sites where observations were conducted might have limited the participants' perspectives represented in the qualitative phase. Due to funds availability, time constraints, and school districts' process for obtaining permission to conduct research, all participants of the second phase of the study were located in the eastern region of the U.S.

Assumptions

One of the assumptions was that the DL teachers who participated in this study are representative of the population of DL teachers in the U.S. Another assumption was that DL teachers participating in the second phase of the study did so openly and honestly.

Researcher as Instrument Statement

My positionality as a researcher is important to note in this study. As a DL educator, I'm an advocate for DL and multilingualism. I am comfortable using technology, and as a teacher, I have used technology for planning, lesson delivery, assessment, and parental engagement. In my final years as a DL teacher, I started trying technology-based activities that were more student-centered (i.e., students creating digital presentations, and students collaborating to record videos). However, it was not until after my teaching career and during my doctoral journey that I learned about the potential of leveraging technology in DL to support content mastery and language development. Although I believe technology can help DL educators and students reach the program goals of bilingualism and biliteracy, academic achievement, and sociocultural competence, I am a proponent of technology integration only if it is to enhance students' learning experiences, and if it is aligned to the learning standards.

I recognize that my professional experiences in DL and attitude toward technology might introduce the risk of bias in my research, therefore, I took measures to avoid this. However, instead of suppressing my experiences and attitudes, I intended to *bridle* (i.e., monitor and

regulate) my evolving understanding (Dahlberg & Dahlberg, 2019) by engaging in reflective memoing and not compromising the results of this study. To reduce researcher bias, I strived to gain a deep and accurate understanding of the phenomenon studied by requesting participants to describe their experiences in detail and with examples to clarify my interpretation of their accounts. Further, data triangulation and member checking served as accountability methods for data analysis and interpretation.

Ethical Considerations

Data collection for this study did not begin until I received permission from the William & Mary IRB. All participants were given a consent form and were required to provide consent by selecting "I agree to participate" in the first section of the survey (Appendix D), which states the purpose of the research and provides a statement of confidentiality. Moreover, those participating in the second phase of the study were required to sign an additional consent form (Appendix G), including the purpose of the research, an explanation of the second phase procedures, and a confidentiality statement. Before starting the qualitative data collection, I sought authorization from school districts where the selected participants worked, following the necessary procedures established by each district.

In the quantitative phase, I did not collect any identifying information, except for those participants who indicated interest in participating in the second phase of the study. In the qualitative phase, pseudonyms were used to protect the participants' identities. All the data collected were organized digitally and saved in an external hard drive and kept in a secure location where only I can access the information. Per federal regulations, data will be kept for 3 years after the completion of the study.

Summary

This study aimed to investigate the different ways DL teachers use technology and the factors that influence their decision-making when using technology. This explanatory sequential mixed methods study used an original survey for data collection in the quantitative strand and observations, interviews, and artifacts in the qualitative strand. The survey was distributed electronically via email and social media. The survey was also used to recruit participants for the qualitative phase. Survey responses were analyzed using descriptive statistics. Once the quantitative phase was finalized, I selected what results were worthy of further explanation and focused on those in the next phase. I decided to focus on DL teachers' decision-making process when using technology and how their use of technology supports the goals of DL. Participants selection for the qualitative phase was based on those who indicated interest in the survey, and those who could better answer the research questions of the second phase. The qualitative data was analyzed using descriptive and in vivo coding. Codes were used to develop emergent themes and patterns. Member checking was employed in the second phase to ensure the accuracy of interpretation. In Chapter 4, I present the results for each phase, quantitative and qualitative. In Chapter 5, I integrate the results from both phases to summarize and discuss the major findings of this mixed methods study.

CHAPTER 4

FINDINGS

In this chapter, I describe the results of this study, which sought to explain how and why dual language (DL) teachers use technology. This study was guided by Mishra and Koehler's (2006) technological pedagogical content knowledge (TPACK) framework, Bunch's (2013) pedagogical language knowledge (PLK), Biesta's et al. (2015) teacher agency framework, and Moersch's (1997) levels of technology implementation (LoTi) framework. The significance of this investigation lies in studying teachers' use of technology within the context of DL programs while applying a sequential explanatory mixed methods research design. To date, no other studies have focused on the ways DL teachers use technology with a large sample (more than 300 participants). Nor have studies explored DL teachers' decision-making process for using technology. Knowledge and understanding of the ways and the reasons why DL teachers use technology provide additional insight into effective instructional practices in DL, which can in turn inform teacher preparation programs, in-service teacher training, and policies at the school or district level.

The study was conducted to answer these research questions:

- Overall R.Q.: How and why do DL teachers use technology?
- Quantitative R.Q.1: In what ways do DL teachers use technology?
    - 1a: In what ways do DL teachers use technology for planning?
    - 1b: In what ways do DL teachers use technology for instruction?

    - 1c: In what ways do DL teachers use technology for assessment?
    - 1d: In what other ways do DL teachers use technology?
- Quantitative R.Q.2: What factors influence teachers' use of technology?
- Qualitative R.Q.1: How do DL teachers describe their decision-making when using technology?
- Qualitative R.Q.2: To what extent do DL teachers use technology to support the goals of DL?

This chapter is organized into two major sections, the quantitative phase results and the qualitative phase results. In the quantitative phase, I investigated the different ways DL teachers use technology and the factors that influence their use of technology. For data collection, I used an original survey, and I analyzed the data using descriptive statistics. In the qualitative phase, I sought to explain DL teachers' decision-making processes when using technology and how the ways teachers use technology help support the goals of DL. I generated data through interviews, observations, and artifacts. I analyzed the data using in vivo and descriptive codes, and I organized the codes into emerging themes. Both quantitative and qualitative sections of this chapter include a description of the participant sample and address the research questions. Finally, the analysis results are summarized to provide an overview of the discussion in Chapter 5.

Quantitative Phase Results

During the quantitative phase, I used the original survey I created, the Dual Language Teachers' Use of Technology Survey (DLTUTS), for data collection. The survey included 47 items including demographic questions and items regarding the ways DL teachers use technology and factors that influence their use of technology. The items in the DLTUTS were

developed from my qualitative pilot study, the Teacher Technology Integration Survey (TTIS) (Vannatta & Banister, 2009), the LoTi survey (LoTi Connection, 2016), recommendations from the *Guiding Principles for Dual Language Education* (Howard et al., 2018), and competencies listed in the ISTE (n.d.) educators' standards. I analyzed the data using the SPSS statistics program. First, I use the demographic data to describe the participants.

Survey Participants

I selected participants based on the following criteria: (a) DL teachers from one-way or two-way DL programs; (b) DL teachers from public schools, charter schools, and private schools; (c) DL teachers teaching in PreK-12 Grades in the 2022-2023 academic year. I employed a convenience and snowball sampling method to recruit participants. Once I received IRB approval, I contacted DL educators via email and social media posts in DL interest groups to invite them to participate and share the invitation with their colleagues.

A total of 314 DL teachers across the United States completed the DLTUTS. The demographics section of the survey included questions about the participants' years of teaching experience (see Table 3). First, the participants indicated their overall teaching experience. Out of the 314 participants, 10% (n = 31) stated having fewer than 5 years of overall teaching experience, 21% (n = 67) indicated having 5–9 years of teaching experience, 45% (n = 140) stated having 10–20 years of teaching experience, and 24% (n = 76) indicated having more than 20 years of overall teaching experience. Secondly, the participants specified their teaching experience in DL. Out of the total participants, 32% (n = 99) had fewer than 5 years of teaching experience in DL, 34% (n = 106) had 5–9 years of teaching experience, 26% (n = 83) had 10–20 years of teaching experience, and 8% (n = 26) had more than 20 years of teaching experience in DL.

Table 3

Survey Participants' Years of Teaching Experience

Years Teaching	Overall experience		Experience in DL	
	n	%	*n*	%
< 5	31	10%	99	39%
5-9	67	21%	106	34%
10-20	140	45%	83	26%
> 20	76	24%	26	8%

Note. DL= dual language

Another demographic question asked participants to state their grade level assignment in the 2022-2023 school year by selecting from three different grade level range options: PreK-Grade 2, Grades 3-5, middle school, and high school (Table 4). Out of the 314 participants, 53% (*n* = 165) taught Grades PreK-2nd, 34% (*n* = 108) taught Grades 3-5, 10% (*n* = 31) taught in middle school, and 3% (*n* = 10) taught in high school. These data correspond to the overall U.S. DL teacher population because more DL programs exist at the elementary school level (Howard et al., 2018).

Table 4

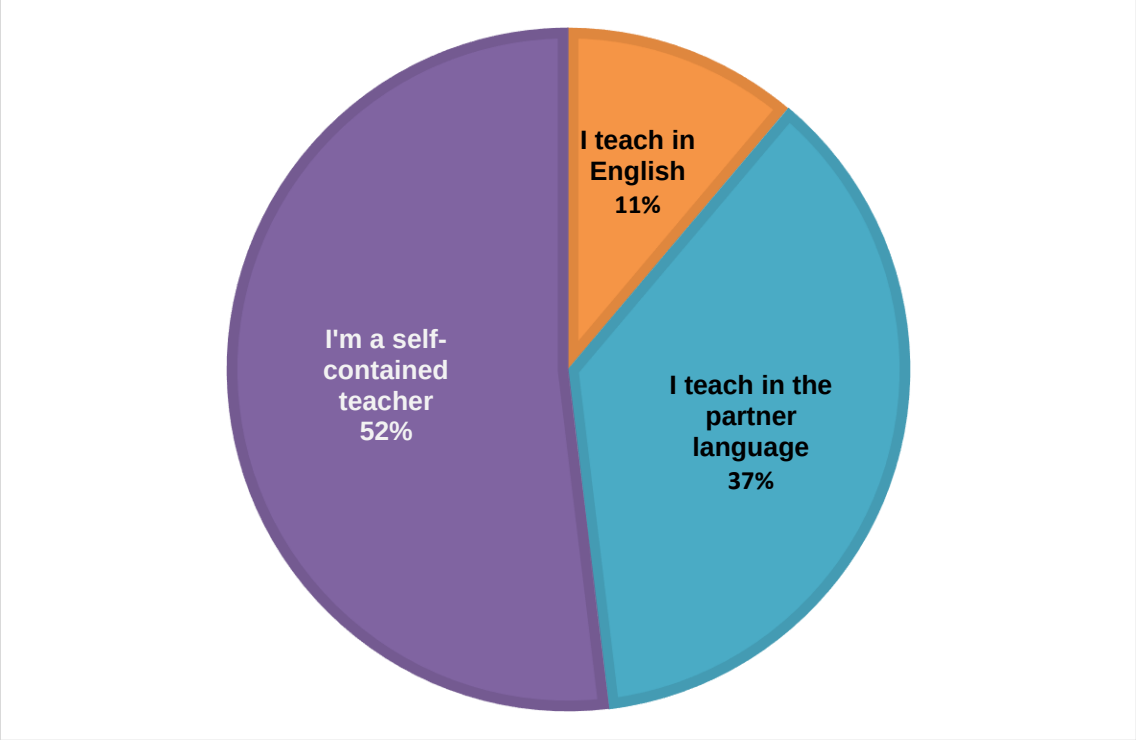
Survey Participants' Grade-Level Assignments

Grade	*n*	%
PreK-Grade 2	165	53%
Grades 3-5	108	34%
Middle school	31	10%
High school	10	3%

Additionally, participants indicated their roles within the DL program (see Figure 4). In total, 52% (*n* = 163) of participants were self-contained DL teachers (taught in English and the partner language), 37% (*n* = 116) taught in the partner language, and 11% (*n* = 35) taught in English.

Figure 4

Participants' Role in the Dual Language Program

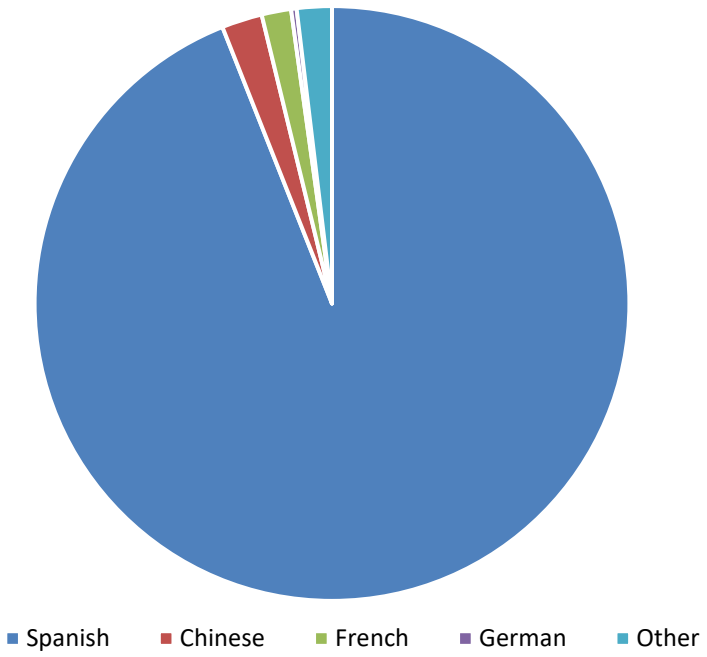


Furthermore, participants responded to questions about the structure of their DL program. Participants were asked about their program's partner language (see Figure 5). In total, 94% (*n* = 295) of participants indicated that the partner language was Spanish, 2% (*n* = 7) of participants indicated that the partner language was Chinese, fewer than 2% (*n* = 5) of participants indicated

that the partner language was French, one of the participants indicated that the partner language was German, and 2% (n = 6) of participants indicated their partner language was other than the options provided. These data are representative of the overall DL programs functioning in the U.S., since Spanish programs account for about 80% of all programs, followed by Chinese (8.6%) and French (5%; American Councils Research Center, 2021). Out of the 314 participants, 27% (n = 84) indicated that the whole school was DL and 71% (n = 224) indicated that DL was a strand within the school; six participants did not answer this question.

Figure 5

Partner Languages in Participants' Dual Language Programs



The last demographic question asked DL teachers about the digital infrastructure in their classrooms. In total, 83% (n = 262) of participants stated that their students had one-to-one

devices, 12% (n = 224) stated that they had access to a shared mobile device cart, 1.3% (n = 4) stated that they had access to a shared computer lab, 0.6% (n = 2) participants stated that their students had to bring their own device, and 2.5% (n = 8) participants selected other. Next, I describe the findings for each quantitative research question.

Quantitative Research Question 1

Research Question 1 asked: In what ways do DL teachers use technology? To address this question a section in the DLTUTS survey asked participants about how they use technology for planning, instruction, assessment, and other purposes. Participants responded to each item by selecting a level of frequency from a five-point frequency scale *Never* (1) to *Very Frequently* (5). Frequencies and descriptive statistics were calculated for each item.

DL Teachers' Use of Technology for Planning. With an n of 314 and no missing values, over 80% of participants indicated that they frequently or very frequently use the internet to learn about a topic that they have to teach and use the internet and social media to find resources and materials for their lessons. Additionally, 74% of respondents specified that they frequently or very frequently use technology to create, adapt, and personalize learning experiences that accommodate learner differences and needs. Likewise, 71% of the participants reported frequently or very frequently using the internet or social media to learn new teaching strategies. Over 60% of respondents indicated using technology frequently or very frequently to create technology-based learning activities for their students and create, adapt, and personalize learning experiences that foster independent learning.

Meanwhile, only 43% of participants stated that they frequently or very frequently collaborate with others to explore the application of digital tools that improve student learning. Similarly, 43% of participants frequently or very frequently create diverse formative and

summative assessments that encourage students to demonstrate their understanding in nontraditional/alternative ways. Finally, 42% of participants frequently or very frequently collaborate and co-learn with students to discover and use new digital resources and diagnose and troubleshoot technology issues. Table 5 illustrates the mean, mode, standard deviation, and frequencies for the nine items included in the use of technology for the planning section of the survey. I combined the percentages for *Frequently* and *Very Frequently* for each item.

Table 5

DL Teachers Technology Use for Planning

Item	*M*	Mode	*SD*	Frequently and very frequently	
				n	%
I use the internet to learn about a topic that I have to teach.	4.3	5	0.9	257	82%
I use digital tools to create technology-based learning activities for my students.	3.86	4	1.0	204	65%
I use the internet/social media to find resources/materials for my units/lessons.	4.4	5	0.8	275	88%
I use technology to create, adapt, and personalize learning experiences that accommodate learner differences and needs.	4.07	5	0.9	232	74%
I use the internet/social media to learn new teaching strategies.	4.01	5	0.9	224	71%
I collaborate with others (e.g., teachers, technology integration coaches) to explore the application of digital tools that improve student learning.	3.33	3	1.1	134	43%
I use technology to create, adapt, and personalize learning experiences that foster independent learning.	3.74	4	1.0	187	60%
I collaborate and co-learn with students to discover and use new digital resources and diagnose and troubleshoot technology issues.	3.22	3	1.1	132	42%
I create diverse formative and summative assessments that encourage students to demonstrate their understanding in nontraditional/alternative ways.	3.29	3	1.1	136	43%

Note. DL= dual language

DL Teachers' Use of Technology for Instruction. With an *n* of 314 and no missing values, 97% of participants indicated that they frequently or very frequently use technology such as a digital whiteboard or document camera to present information and 90% stated that they frequently or very frequently use technology to provide diverse and current curriculum resources (e.g., photos, videos) in the language they teach. Most respondents (78%) specified frequently or very frequently using diverse technology tools to address content standards and 72% of participants reported managing students' use of technology and student learning in digital platforms. Most participants (65%) stated that they frequently or very frequently use technology tools to address language and literacy standards and 64% of participants reported using digital tools (e.g., videos, online simulations) to provide comprehensible input. Similarly, 56% of respondents specified that they frequently or very frequently assign students technology-based activities that help them produce oral or written language.

Only 34% of participants indicated that they frequently or very frequently provide their students with opportunities to work in groups to create web-based or multimedia presentations. Additionally, 29% of participants stated that they frequently or very frequently empower their students to self-select the most appropriate digital tool to aid them in completing a given task. Some participants (28%) reported that their class frequently or very frequently uses digital tools to participate in problem-solving activities with others beyond the classroom. Table 6 illustrates the mean, mode, standard deviation, and frequency for the 10 items included in the use of technology for the instruction section of the survey. I combined the percentages for *Frequently* and *Very Frequently* for each item.

Table 6

DL Teachers Technology Use for Instruction

Item	*M*	Mode	*SD*	Frequently and very frequently	
				n	%
I use technology (e.g., SmartBoard, document camera, projector) to present information.	4.82	5	.47	303	97%
I use technology to provide diverse and current curriculum resources (e.g., photos, videos, virtual field trips, primary source materials) in the language I teach.	4.52	5	.70	284	90%
I use diverse technology tools to address content standards.	4.15	5	.83	245	78%
I manage students' use of technology and student learning in digital platforms or virtual environments (e.g., CANVAS, Seesaw, Google Classroom).	4.04	5	1.11	227	72%
My class uses digital tools to participate in problem-solving activities with others beyond the classroom.	2.69	5	1.32	89	28%
I use technology tools to address language and literacy standards.	3.84	2	.93	104	66%
I assign students technology-based activities that help them produce oral or written language.	3.53	4	1.15	176	56%
I use digital tools (e.g., multimedia, online tutorials, online simulations, videos) to provide comprehensible input.	3.79	4	1.05	201	64%
I provide my students with opportunities to work in groups to create web-based or multimedia presentations (e.g., Prezi, PowerPoint, Google Slides, eBooks).	2.83	4	1.42	108	34%
I empower my students to self-select the most appropriate digital tool to aid them in completing a given task.	2.76	1	1.26	91	29%

Note. DL= dual language

DL Teachers' Use of Technology for Assessment. Overall, the means of the items that measured technology use for assessment were lower when compared to the items that measured

technology use for planning and instruction. With an *n* of 314 and no missing values, 49% of participants indicated that they frequently or very frequently use technology to assess students' understanding of content, and 43% specified that they frequently or very frequently use technology to assess students' language skills. Similarly, 46% of respondents reported that they frequently or very frequently provide different formative and summative assessments that encourage students to demonstrate their understanding in nontraditional ways. Nearly half of participants (45%) indicated that they frequently or very frequently use game-based student response system tools (e.g., Kahoot, Quizizz) to reinforce concepts taught. Similarly, 40% of participants specified that they frequently or very frequently use technology to monitor students' language development and biliteracy progress

Only 35% of participants reported that they frequently or very frequently provide timely and constructive feedback to students using technology. Likewise, 30% of respondents stated that they frequently or very frequently use student-centered performance assessments that involve students transferring what they have learned to a real-world context using diverse digital tools. Table 7 illustrates the mean, mode, standard deviation, and frequency for the seven items included in the use of technology for assessment section of the survey. I combined the percentages for *Frequently* and *Very Frequently* for each item.

Table 7

DL Teachers Technology Use for Assessment

Item	*M*	Mode	*SD*	Frequently and very frequently	
				n	%
I use technology to provide timely and constructive feedback to students.	2.92	3	1.22	211	35%
I use student-centered performance assessments that involve students transferring what they have learned to a real-world context using diverse digital tools.	2.81	2	1.20	93	30%
I use technology to assess my students' understanding of content.	3.46	3	1.06	155	49%
I use technology to assess my students' language skills.	3.26	3	1.05	136	43%
I provide different formative and summative assessments that encourage students to demonstrate their understanding in nontraditional ways.	3.29	4	1.08	143	46%
I use technology to monitor students' language development and biliteracy progress.	3.19	3	1.10	126	40%
I use game-based student response system tools (e.g., Kahoot, Pear Deck, Quizizz) to reinforce concepts taught.	3.25	3	1.29	141	45%

Note. DL= dual language

DL Teachers' Use of Technology for Other Purposes. With an *n* of 314 and no missing values, 82% of participants indicated that they frequently or very frequently use applications to regularly communicate with parents, while 58% send electronic newsletters to communicate with families. Additionally, 45% of the respondents reported that they frequently or very frequently use technology for holding conferences virtually. Only 39% of participants specified that they frequently or very frequently use applications to send families tips/resources for supporting their children’s language development. Moreover, 70% of participants stated that they frequently or

very frequently use technology for professional development purposes (e.g., webinars, virtual conferences) and 38% use the internet or social media to collaborate with other DL teachers outside their district. Table 8 illustrates the mean, mode, standard deviation, and frequency for the six items included in the use of technology for other purposes section of the survey. I combined the percentages for *Frequently* and *Very Frequently* for each item.

Table 8

Other Ways DL Teachers Use Technology

Item	*M*	Mode	*SD*	Frequently and very frequently	
				n	%
I use applications to regularly communicate with parents.	4.2	5	1.03	256	82%
I send electronic newsletters to communicate with families.	3.58	5	1.45	183	58%
I use applications to send families tips/resources for supporting their children's language development.	3.17	3	1.29	122	39%
I use technology for holding conferences virtually.	3.4	3	1.17	142	45%
I use technology for professional development purposes (e.g., webinars, virtual conferences, and news from the field).	3.99	4	.91	220	70%
I use the internet/social media to collaborate with other dual language teachers outside of my district.	3.03	3	1.33	120	38%

Note. DL= dual language

Quantitative Research Question 2

Research Question 2 asked: What factors influence teachers' use of technology? To address this question a section in the survey asked participants about factors that contribute to and factors that inhibit their use of technology. Participants responded to each item by indicating

their level of agreement with it with a five-point Likert-type response format ranging from *Strongly Disagree* (1) to *Strongly Agree* (5).

Factors that Contribute to DL Teachers' Use of Technology. With an *n* of 314 and no missing values, 98% of participants indicated that they somewhat agree or strongly agree that technology can be an effective learning tool for students. In total, 88% of respondents stated that they somewhat agree or strongly agree that teaching students how to use technology is part of their job and 85% reported feeling excited when they can show students a new technology application or tool. Additionally, 85% of participants specified that they somewhat agree or strongly agree that technology allows them to address the goals of DL (bilingualism, biliteracy, academic achievement, and sociocultural competence). In all, 91% of respondents indicated that they somewhat agree or strongly agree that they feel comfortable working with digital technologies and 79% feel confident with their ability to troubleshoot when problems arise while using technology. Moreover, 74% of participants reported that they somewhat agree or strongly agree that it is mandatory in their school/district to use certain digital tools (e.g., reading or math applications). Regarding technology support in their school to assist with troubleshooting, 71% of respondents stated that they somewhat agree or strongly agree that it is available to them.

Only 38% of participants indicated that they somewhat agree or strongly agree that a technology integration coach is available in their school to assist with technology integration ideas. In addition, 25% of respondents specified that they somewhat agree or strongly agree that they receive professional development for technology integration specific to DL (e.g., content and language skills, target language resources). Table 9 illustrates the mean, mode, standard deviation, and frequencies for the 10 items included in the section of the survey that measured

the factors contributing to DL teachers' use of technology. I combined the percentages for *Somewhat Agree* and *Strongly Agree* for each item.

Table 9

Factors That Contribute to DL Teachers' Use of Technology

Item	*M*	Mode	*SD*	Somewhat agree and strongly agree	
				n	%
Teaching students how to use technology is a part of my job.	4.29	5	.90	276	88%
Technology can be an effective learning tool for students.	4.71	5	.52	306	98%
I get excited when I am able to show my students a new technology application or tool.	4.33	5	.86	267	85%
Technology allows me to address the goals of dual language (bilingualism, biliteracy, academic achievement, and sociocultural competence).	4.22	5	.84	266	85%
I feel comfortable working with digital technologies.	4.4	5	.83	287	91%
I am confident in my ability to troubleshoot when problems arise while using technology.	3.94	4	1.05	248	79%
It is mandatory in my school/district that I use certain digital tools (e.g., reading or math applications).	3.99	5	1.29	232	74%
Technology support is available in my building to assist with troubleshooting.	3.78	5	1.31	222	71%
A technology integration coach is available in my building to assist with technology integration ideas.	2.77	1	1.56	118	38%
I receive professional development for technology integration specific to dual language (e.g., content and language skills, target language resources).	2.25	1	1.30	79	25%

Note. DL= dual language

Factors That Inhibit DL Teachers' Use of Technology. With an *n* of 314 and no missing values, 85% of participants indicated that they somewhat agree or strongly agree that one of their challenges for technology integration is the lack of planning time, while 76% of participants identified the lack of resources in the language they teach as another challenge. In all, 52% of respondents specified that they somewhat agree or strongly agree that they are not able to implement technology-based activities because they do not have enough time in their instructional day. Additionally, 36% of participants stated that they somewhat agree or strongly agree that they get anxious when using new technologies because they don't know what to do if something goes wrong. Only 28% of respondents indicated that they somewhat agree or strongly agree that testing or standardized testing practice makes it difficult to implement creative technology-based activities. Table 10 illustrates the mean, mode, standard deviation, and frequencies for the five items included in the section of the survey that measured the factors inhibiting DL teachers' use of technology. Each item's percentages for *Somewhat Agree* and *Strongly Agree* were combined.

Table 10

Factors That Inhibit DL Teachers' Use of Technology

Item	*M*	Mode	*SD*	Somewhat agree and strongly agree	
				n	%
One of my challenges for technology integration is the lack of planning time.	4.21	5	.99	268	85%
I get anxious when using new technologies because I don't know what to do if something goes wrong.	2.76	2	1.28	112	36%
I'm not able to implement technology-based activities because I don't have enough time in my instructional day.	3.13	4	1.31	162	52%
One of my challenges when integrating technology is the lack of resources in the language I teach.	3.93	5	1.26	238	76%
Testing or standardized testing practice makes it difficult to implement creative technology-based activities.	3.46	4	1.24	175	28%

Note. DL= dual language

In the quantitative portion of this sequential mixed method study, I addressed the different ways DL teachers use technology as well as the different factors that impact their use of technology. In the qualitative portion of this study, my goal was to gain insight into DL teachers' decision-making process regarding their use of technology as well as to what extent their use of technology supports the goals of DL. In the next section, I address the qualitative results.

Qualitative Phase Results

After having completed the quantitative data collection and analysis process, I identified five DL teachers to participate in the second phase of this study. I selected participants based on their willingness to be part of the second phase of this study and their survey responses. I generated data through two interviews per participant, field notes taken during two observations of 90 minutes per participant, and artifacts collected during observations. I analyzed the verbatim

interview transcripts using descriptive and in vivo codes. I analyzed the field notes using descriptive codes. Next, I organized the codes from both, interviews and fieldnotes, into emerging themes. The artifacts collected were illustrations of what I observed. While the quantitative data provided results for DL teachers' use of technology and factors that influence such use, the qualitative data allowed for a deeper dive into how DL teachers use technology to support the goals of DL. Moreover, the data generated in this phase provided an exploration of DL teachers' decision-making process when integrating technology. Next, I describe the participants of the qualitative phase and address the two research questions of this phase.

Participants

First, I looked at the survey responses to determine those who were willing to participate in this phase. From the total survey responses, 123 participants indicated that they were willing to be part of the second part of the study which included interviews and observations. I narrowed the possible participants by considering my ability to complete the observations in their classrooms within a reasonable travel distance. I preselected participants based on their survey responses trying to capture a variety of grade levels and different levels of technology use (i.e., from teacher-directed to student-centered approaches). After considering the processes for obtaining permission to conduct research for various school districts, I decided to seek permission from the two school districts that seemed to be the most feasible for conducting the observations promptly. After identifying and securing agreement from five teachers to participate in this phase of the research, I sought permission to conduct research from the two school districts. Once I obtained approval, I emailed the participants (Appendix E) to schedule interviews and observations.

All the participants taught in English/Spanish DL programs that were a strand within a school; that is, only a few classes per grade level were part of the DL program in the school. Four out of five participants taught in elementary and one in middle school. Participants' overall teaching experience varied from novice to more than 20 years, however, all participants had three years or less of teaching experience in DL. All participants had access to a computer, internet connectivity, an interactive whiteboard, a document camera, and a one-to-one device digital infrastructure for their students. Table 11 provides a summary of the five participants' demographics.

Table 11

Qualitative Phase Participant Demographics

Participant	Years Teaching	Years Teaching DL	Grade	Role
Tamara	10-20	2	K & 1st	Spanish-immersion
Eleanor	> 20	2	3rd	English-immersion
Adriana	5-9	2	3rd	Spanish-immersion
Ana	5-9	< 1	2nd	self-contained
Isabela	< 5	3	6th & 7th	Spanish-immersion

Note. All participant names are pseudonyms. DL = dual language

Tamara was a Spanish-immersion teacher and taught both Kindergarten and First Grade. She was a native Spanish speaker. She helped her district start the DL program and collaborated with the program instructional specialist to create a curriculum for Spanish language arts and

adapt the district's social studies, science, and math curricula to be taught in Spanish. The school year 2022-2023 was Tamara's second year teaching in the DL program. Eleanor and Adriana were Third Grade partner teachers. They each had a homeroom class, but they shared their students. Adriana's homeroom started the day learning language arts and math in Spanish with her, then in the afternoon transitioned to Eleanor to receive instruction in language arts, social studies, or science in English, and vice versa. Eleanor had more than 20 years of experience in education as a teacher and school administrator. She had received specialized training in teaching English as a second language, teaching talented and gifted students, and in STEM. Adriana came from a Spanish-speaking country and had experience teaching elementary school there. The 2022-2023 academic year was the second year Adriana and Eleanor worked together in their school and the DL program.

Ana taught second grade and she was a self-contained teacher; thus, she taught half of the day in English and the other half in Spanish. She was a heritage Spanish speaker. She taught literacy in English and Spanish, social studies in English, math in Spanish, and science in Spanish. Ana had previously taught first grade at a different school in the same district but decided to change schools to teach in the DL program. The 2022-2023 academic year was the first year Ana taught in the DL program. Isabela was a middle school teacher who taught Spanish language arts to students in the DL program and Spanish as a foreign language to general education students in sixth and seventh grades. Isabela was a native Spanish speaker. Her experience included being an instructional assistant in an elementary school with a high population of emergent bilinguals and teaching math in Spanish in fourth and fifth grades in the same district. The 2022-2023 academic year was Isabela's third year teaching in the DL

program, but her first year teaching at the secondary level and teaching Spanish language arts. In the sections that follow, I address the research questions of the qualitative phase.

Qualitative Research Question 1

The first qualitative research question asked: How do DL teachers describe their decision-making when using technology? To address this question participants were asked to elaborate on some of their survey responses during the first interview. I also asked follow-up questions in their second interview after I completed observations and collected artifacts. Specifically, teachers were asked why they used certain technology tools or facilitated certain technology-based activities. Seven themes emerged to explain DL teachers' decision-making when using technology. Table 12 presents the themes and subthemes along with participants' sample quotes or field notes. Following the table, I describe each theme and subtheme.

Table 12

DL Teachers' Description of Their Decision-Making When Using Technology

Themes and subthemes	Example quotes or fieldnotes
Student consideration	
enjoyment	"They are playing, but they are still learning."
competition	"El sentido de competencia les ayuda" [the sense of competition helps them].
engagement	"Es algo que les llama la atención" [it's something that grabs their attention].
autonomy	Students were given a choice on how to respond to the Nearpod
academic benefits	"Pueden aprender, practicar las destrezas." [they can learn, practice the skills].
differentiation	"activities geared toward them"
Teacher beliefs	"It [technology] is a knowledge tool"
Convenient for teacher	"It saves automatically and can be easily shared with me"
Collegial support	the ITC "me ha enseñado toda la tecnología" [has taught me all the I know about technology].
Teacher agency	
Extra effort	Teachers enrolled their students in a computer challenge held at a university on a Saturday.
Flexibility	"Puedo hacer un ajuste" [I can make an adjustment].
Seeking help	"yo he pedido mucho" [I've asked many times]
Barriers to exercising agency	"I have to do what I'm told."
Supporting DL goals	
Bilingualism/biliteracy	"para mi es una buena fuente ya que ellos adquieren más vocabulario" [for me is a good source because they acquire more vocabulary].
Academic achievement	"La música ayuda a que se les peguen los conceptos." [Music makes the concepts stick].
Sociocultural competence	Applications were used to expose students to different cultures.
Challenges	
Planning time constraint	Our planning time was taken away from us.
Instructional time constraint	"el tiempo para español es poquito" [there's little time for Spanish].
Lack of resources in the LOTE	No hay mucho de donde escoger. [There's no much to choose from].
Lack of ITC/tech support	"my really good support was gone."
District/school mandates	"a program that the school system has chosen and mandated for us to use"
Other issues	Some websites with Spanish resources were blocked on the students' laptops, so Tamara had to present them whole group.

Note. DL= dual language; LOTE= language other than English; ITC= instructional technology coach.

When describing their decision-making process for using technology, DL teachers mentioned different factors. The teachers took into consideration their students, their own beliefs about technology, and the convenience that technology afforded them. DL teachers also explained that collegial support influenced their use of technology. Moreover, teachers' use of technology was affected by their sense of agency and their ability or inability to exercise their agency. Furthermore, when making decisions about what digital tools to use or what kind of technology-based activity to include in their lessons, DL teachers considered the three goals of DL: bilingualism and biliteracy, academic achievement, and sociocultural competence. Finally, the teachers identified some challenges that constricted their use of technology and affected their decision-making. I provide a detailed explanation of these seven themes including their subthemes next.

Student Consideration. When asked to explain their reasoning for integrating technology, DL teachers expressed consideration for their students' interests. The participants wanted to provide fun learning activities for their students, appeal to their students' competitive drive, and increase their students' engagement. The DL teachers sought to use digital tools that helped them develop independent learners, provided academic benefits for their students, and enabled them to differentiate according to their students' mastery levels of content and language skills. There are six sub-themes included in the student consideration theme: enjoyment, competition, engagement, autonomy, academic benefits, and differentiation. Next, I describe each one of these sub-themes in further detail.

Enjoyment. The DL teachers explained that their students enjoy working with technology and often prefer to engage with different applications than using paper and pencil. For instance, when describing her students, Ana expressed "these kids of this generation are very into

technology." Eleanor specified that she used BrainPOP videos, standards-aligned cartoon movies, because her students "enjoy it…it gets them excited. They like the characters…it's a fun way to get the point across to the kids." Similarly, Tamara stated that she used Liveworksheets, self-correcting digital interactive worksheets, because her students preferred it to the paper version. She explained, "los niños son mucho de computadora, muy tecnológicos, entonces ellos piensan que solamente porque está en el computador, no es trabajo" [the children are very computer oriented, very technological, so they think that just because it is on the computer, it is not work.]. Overall, teachers asserted that their students see digital applications "como un juego" [as a game] and that "they are playing, but they are still learning." Three out of the five participants mentioned that their students "disfrutan mucho" [really enjoy] game-based educational applications.

Competition. Closely related to enjoyment, is the sub-theme of competition. Two DL teachers stated that some digital applications triggered their students' sense of competition which motivates and engages them. Eleanor indicated that her students see technology-based projects as "challenges" and that is a motivating factor for them. Tamara also shared that when her students work with gamified digital applications their engagement and motivation to complete a task increased. She stated, "ellos sienten que están compitiendo, y eso los pone, you know, excited, y piensan que es un challenge. Quieren participar y quieren demostrar lo que saben" [they feel like they are competing, and that gets them, you know, excited, and they think that it's a challenge. They want to participate, and they want to show what they know].

Engagement. DL teachers believed that technology was engaging for their students because they enjoyed working with it. Adriana explained that she used technology because "es algo que les llama la atención" [it is something that grabs their attention]. Similarly, Ana added

about her students, “their play is technology. I want to have a way to engage them, and I think that technology is the way to engage them and get them interested in learning, and sometimes a lot of the technology is game based.” Four teachers stated that they use Google Slides, online slideshows, because it makes their instruction more “engaging,” “interesting,” and “interactiva” [interactive]. Ana described the use of her avatar in her slide deck as a way to engage her students and make instruction “a little bit more fun.” She pointed out that her students “look forward to seeing the slides.” An example of one of her slides is included in Appendix L.

Autonomy. DL teachers explained that technology affords students autonomy as they can work independently and are given a choice on what digital tools to use when completing tasks. All the participants assigned their students independent work that included completing classwork or accessing different content applications on their laptops. Eleanor explained that she had established a learning community in which her students were encouraged to look for information and answer their own questions using Google or other educational resources. Isabela stated that she used Canvas, a learning management system, to assign students work and students were able to use a digital tool of their choice to respond to it. She indicated, “les doy a ellos la oportunidad de usar la plataforma que ellos más cómodos se sientan” [I give them the opportunity to use the platform they are most comfortable with]. Ana preferred using Nearpod, a software for creating multimedia, to assign independent work because it provided her students with different opportunities to show their knowledge as they could choose from different features such as voice recording, drawing, stylus writing, or typing.

Academic Benefits. The DL teachers indicated that they also used technology because it benefitted their students academically. For instance, when describing the use of Imagine Español, a Spanish language and literacy application, Adriana explained that native English

speakers benefitted from reviewing vocabulary. She also stated that using Google Slides on the digital whiteboard for presenting information during math lessons supported her students' learning because "puedo integrar a los niños y ellos pueden ver los ejemplos en la pizarra" [I can incorporate the kids and they can see the examples on the board]. She mentioned calling on students to use the digital whiteboard to show how they solved math problems, which helped the rest of the class. Isabela also stated that some digital applications such as Liveworksheets were helpful for her students because "ellos pueden aprender, practicar las destrezas" [they can learn, and practice the skills] of the concepts taught in class.

***Differentiation*.** Finally, technology enabled teachers to differentiate instruction to the student's level of proficiency. All the participants discussed how digital applications such as math, English, and Spanish literacy programs provided their students with a personalized learning path. Isabela explained that technology "se ajusta a cada forma de cada estudiante…a los diferentes niveles, ritmos" [it adjusts to the way of each student…to the different levels and pacing]. In addition, Ana used *Canvas* to assign students differentiated work. She divided her students into groups for reading instruction and each group had a different button to click on for their independent reading work. The buttons contained "activities geared toward them" and matched the skills that each group was learning with her in small-group instruction.

Teacher Beliefs. Overall, the five participants believed that technology could increase students' engagement, improve students' learning experiences, and support the goals of DL. The teachers believe that technology is a helpful tool for them to provide instruction and for their students to enhance their learning. Eleanor explained that technology was "a knowledge tool" and that it was embedded in her science curriculum. She stated that she used technology "to get science across in an easier way." The participants believed that technology was complimentary

to their instruction, and it helped their students understand the concepts taught. Isabela indicated that with technology her students "pueden entender lo que estan aprendiendo" [they can understand what they are learning]. The teachers believed that technology was engaging because it was "interactiva" [interactive].

Convenient for Teachers. The DL teachers expressed feeling comfortable with technology and being used to using certain applications such as Google Slides and learning management systems (Canvas and Google Classroom) because they were easy to use. The five teachers referred to Google and YouTube as tools that they used frequently because "es lo mas fácil para buscar" [it is the easiest thing to search]. Tamara explained that interactive digital worksheets meant "ahorramos en sacar tanto papel" [we save paper copies]. Adriana stated that it was "más fácil" [much easier] to teach math with Google Slides than with the teacher manual. Similarly, Isabela specified that she used Google Slides because "fue la primera plataforma que yo aprendí cuando comencé. La aplicación graba automáticamente y me facilita crear mis clases" [it was the first platform I learned when I started. The application saves automatically and makes it easy for me to create my classes]. Adriana also indicated using Nearpod for math exit tickets because the data was readily accessible and she could easily determine which students still needed support with a skill. Ana stated that she liked using Imagine Español, an application provided by her district, because it had extra resources for teachers. Eleanor claimed that she used Google Suite applications because students knew how to work with them, they saved automatically, and because students could easily share their work with her.

Collegial Support. All the participants identified at least one person who collaborated with them and/or supported them with their instruction and their use of technology. Four out of the five teachers reported collaboratively planning with a DL specialist, a DL instructional

coach, or both. Three out of the five participants mentioned having the support of an information technology coach to help them plan with technology or a technician to assist them with technology malfunctions. For example, Adriana stated, the information technology coach "me ha enseñado toda la tecnología" [has taught me all the I know about technology]. Ana indicated that she worked together with her grade-level team and sometimes with her information technology coach. Both Ana and Adriana, reported using social media, *Facebook* interest groups, or *TikTok*, to collaborate with other teachers, learn new teaching strategies, and find resources.

Teacher Agency. Another factor that influenced DL teachers' decision-making when using technology was their sense of agency. Four subthemes are included in teacher agency: extra effort, flexibility, seeking help, and barriers to exercising agency. These are further explained next.

Extra Effort. To a great degree, all the participants exhibited behaviors that showed that they were willing to exceed regular professional expectations. They were willing to do more for the sake of their students and the DL program itself. Ana stated, "I use technology a lot for looking up stuff for my kids" as she was constantly looking for materials and technology-based activities that could enhance her students' learning experiences. Additionally, all the Spanish-immersion teachers mentioned working extra hours daily and on weekends to prepare their lesson materials, which often included translating. Besides teaching two different grade levels, kindergarten and first grade, Tamara also wrote a curriculum for Spanish language arts. She stated, "yo quiero que esto funcione" [I want this to work] when talking about the DL program she worked for. Ana mentioned that looking for digital resources did not take away from her planning time because it helped her students. The third-grade teacher partners, Eleanor and Adriana, enrolled six of their students in a computer challenge competition that took place on a

university campus on a Saturday. They decided to enroll their students because they wanted to give them “una visión diferente” [a different vision]. They wanted their students to start thinking about college, to experiment with technology, and to “get exposed to what’s out there.”

Flexibility. Two participants in particular, Tamara and Eleanor, talked about and exhibited flexibility to fit the needs of their students and the DL program. Tamara stated, “yo soy muy flexible” [I’m very flexible] when discussing her willingness to make changes as needed to better serve her students and the DL program. She also reported, “puedo hacer un ajuste” [I can make an adjustment] when referring to adjusting her instructional time to be able to integrate technology and meet curriculum expectations. Differently, Eleanor showed flexibility in her instruction as she took advantage of technology tools to capitalize on teachable moments. For instance, when her students did not understand the meaning of a word, she immediately looked for a picture of it on the internet using the digital whiteboard. Ana was also flexible with the district’s curriculum implementation, for instance, during math instruction, she used videos that were not included in the math curriculum to build on students’ background knowledge.

Seeking Help. Three out of the five DL teachers sought to improve their instructional practices and resources by collaborating with others. Ana indicated that she not only followed other DL teachers on social media but also wrote to them to ask them questions about certain instructional strategies. Similarly, Adriana mentioned that she often communicated with colleagues from her home country to ask them for help with finding resources in Spanish for the topics she needed. Tamara advocated for resources in Spanish for her students; she expressed, “yo he pedido mucho” [I’ve asked many times] referring to making requests from her district.

Barriers to Exercising Agency. Four out of the five participants identified certain factors as difficult to overcome. Consequently, under certain circumstances, the teachers were unable to

enact their agency. For instance, Ana recognized that her technology approach could be more student-centered, however, she claimed that the curriculum constraints restricted her creativity. She also believed that some district-mandated applications were not as helpful for her students and she wished she could make changes. However, she stated, “I have to do what I’m told.” Tamara tried to be flexible with the district’s curriculum implementation, however, at times it was difficult to allot time for small group reading instruction in Spanish. Adriana and Isabela were new in their role, and they did not feel comfortable enough to try new digital tools or to engage their students with problem-solving using digital tools. Moreover, lesson planning was time-consuming, and their planning time was limited.

Supporting DL Goals. When making decisions about technology use, participants considered the goals of DL: bilingualism and biliteracy, academic achievement, and sociocultural competence. Each one of these three goals is a subtheme and is further explained next.

Bilingualism and Biliteracy. DL teachers used technology tools to provide their students with nonlinguistic supports; thus, offering comprehensible input. Mostly, teachers used slide decks, pictures, and videos to complement their instruction. The five participants also selected or preferred using certain educational applications that supported students’ language development. For example, Ana used Nearpod because she could link videos to it, she could record her voice reading the text, and students could complete a given task by writing, making a picture, or recording their voice. Eleanor liked using Smarty Ants, an English reading application acquired by the district, because it provided her students with foundational skills in reading, and both she and her students could track their literacy progress. Similarly, Ana and Adriana liked using Imagine Español because it supported their students’ language development in all four domains

(i.e., reading, writing, speaking, and listening). Adriana explained, “para mi es una buena fuente ya que ellos adquieren más vocabulario” [for me is a good source because they acquire more vocabulary]. Isabela assigned her students work in *This is Language*, an online platform that includes videos and interactive exercises, so that they could practice listening and speaking. *This is Language* was part of her Spanish as a Foreign Language curriculum, but sometimes she used it with her DL classes.

Academic Achievement. All the participants used different digital tools for concept development, vocabulary practice, and concept application to support the academic achievement of their students. For concept development (e.g., introducing new topics), the teachers frequently used YouTube videos. Music was used for vocabulary acquisition and practice as Tamara explained, “si me paro y repito y hago que ellos repitan no lo agarran tan fácil como si lo bailan, o lo cantan. La música ayuda a que se les peguen los conceptos” [if I stand up and repeat and have them repeat it, they don't pick it up as easily as if they dance to it or sing it. Music makes the concepts stick]. In addition, gamified applications, software, or websites that include gaming elements served as vocabulary practice and concept application. Isabela also explained that Liveworksheets helped her students apply the concepts taught and “aclarar las dudas que tenían” [clarify any doubts they had].

Sociocultural Competence. The participants believed that technology was an effective tool to support classroom community building and increase their students’ sociocultural awareness. For instance, some digital tools such as Imagine Español, Liveworksheets, or YouTube videos, included material with audio from Spanish speakers from different countries, which exposed students to “diferentes culturas” and different dialects and accents. Tamara, Adriana, and Isabela explained that this exposure resulted in discussions with students about the

different ways to name an item in different Spanish-speaking countries and how all the different ways were valid.

Challenges. The DL teachers also identified challenges that influenced their use of technology. Six subthemes included within challenges are: planning time constraints, instructional time constraints, lack of resources in the language other than English, limited access to an information technology coach or tech support, district/school mandates, and other issues. I describe these subthemes below.

Planning Time Constraints. Four of the five participants reported having limited time for planning. Eleanor claimed, "our planning time was taken away from us." Eleanor and her partner teacher, Adriana, explained that because during their allotted planning time they were expected to attend meetings, they did not have a planning period. Adriana stated, "no tengo el tiempo para hacer mi trabajo y para mí [las reuniones] son tiempo perdido, porque tengo que pasar mi fin de semana en mi casa, planificando y haciendo todo" [I don't have the time to do my work and for me (the meetings we have) are wasted time, because I have to spend my weekend at home, planning and doing everything]. Sometimes the partner teachers did not have time for planning because of other teachers' absences. Therefore, it was difficult for Adriana to take the necessary time to learn how other digital applications worked or how she could incorporate them. Likewise, Isabela and Ana indicated that the information technology coach in their school was readily available to collaborate with, however, they did not have the time to plan together.

Instructional Time Constraints. Another constraint was the limited instructional time Spanish-immersion teachers at the elementary level had for Spanish language arts. Tamara stated that she was flexible and could adjust times, however, she acknowledged that it was difficult to fit in reading small group instruction with both classes. The difficulty was greater with her

afternoon class because of scheduling and transitions. Similarly, Adriana reported that “el tiempo para español es poquito” [there’s little time for Spanish] because the expectation was for a math block of 90 minutes, which only allowed for a 30-minute Spanish literacy block. Ana also mentioned that her instructional time was limited because she was expected to have her students work on district-purchased literacy and math applications for a required number of minutes daily.

Lack of Resources in the language other than English. Another challenge experienced by all participants was the limited access to digital resources in Spanish. For instance, Tamara taught science and math in Spanish and was expected to follow the district curriculum, yet all resources provided were in English. Tamara translated some of the materials, but others were not editable, so, she had to find similar resources in Spanish. She had to search and curate videos that were similar to the ones in English included in the curriculum, however, she stated, “no hay mucho de donde escoger” [there’s not much to choose from]. Tamara reported that her students had access to several literacy applications in English, “pero en español no hay un producto que ha sido comprado” [but no product has been purchased in Spanish yet]. She requested that her district gain access to educational applications in Spanish. Ana also mentioned that more resources were available in English, but she hoped “to get more resources in Spanish as the program grows.”

Limited Access to Tech Support. Two of the five participants lacked effective support from an information technology coach or technician. Tamara stated that there was no information technology coach in her building, but a tech support person was available to them, although he was shared between two schools. Eleanor expressed her dissatisfaction with the information technology coach and tech support available in her school. She explained that in previous years an information technology coach and technician were easily accessible, however, in the 2022-

2023 school year she did not have the same support. Her school was assigned a new information technology coach, whom she did not find very helpful, so she felt that her "really good support was gone." Eleanor also claimed that she had to wait a while for a technician to complete her repair requests. She stated, "the kids are so excited about something, and something doesn't work and if somebody is not there to help immediately, then it's kind of lost. You lose that moment."

District/School Mandates. Four out of the five participants were required to use certain digital tools such as a specific learning management system, a math application, an English literacy application, and some of them, a Spanish literacy application. These applications were to be used by students for a required number of minutes daily or weekly. Some of the participants believed that not all of the required applications were beneficial for their students. For instance, Ana explained that she did not like the English literacy and the math programs because they did not work at the students' actual proficiency level. Eleanor mentioned that at first, she did not like the English literacy program. She stated that it was "a program that the school system has chosen and mandated for us to use… I had to buy into it last year and now this year I'm seeing the growth." She believed it helped her students with foundational reading skills, however, the program had "a glitch" and often students had to repeat sections "over and over again" and could not move on until they mastered a particular skill, which caused frustration.

Other Issues. There were other challenges identified by the participants. Tamara stated that some of the websites with Spanish resources were blocked in the school network, or the students' laptops, so she could not use them or could only use them on her computer and present them whole group. Isabela, the middle school DL teacher, explained that because there was no other teacher in her school or the district that taught Spanish language arts for DL students in middle school, she did not have peers to collaborate with. Furthermore, Eleanor claimed that the

professional development teachers received was not very effective as it mostly consisted of training in curriculum updates. Therefore, teachers were not well prepared to use technology for problem-solving or in a student-centered manner. In the next section, I address the results of the second research question of the qualitative phase.

Qualitative Research Question 2

The second qualitative research question asked: To what extent do DL teachers use technology to support the goals of DL? To address this question I conducted observations, collected artifacts, and asked participants observation follow-up questions in their second interview. Specifically, teachers were asked how certain technology tools or certain technology-based activities they facilitated supported their students' bilingualism and biliteracy, academic achievement, and sociocultural competence (see Appendix M for a list of digital tools used by the participants). Four themes related to using technology to support the goals of DL emerged from the data. Table 13 presents the themes and subthemes along with participants' sample quotes or field notes. Each theme and subtheme is described in detail after the table.

Table 13

DL Teachers' Description of Their Use of Technology to Support DL Goals

Themes and Subthemes	Example
Supporting bilingualism and biliteracy	"su oído se va ajustando a entender el idioma" [their hearing is adjusting to understanding the language].
Supporting academic achievement	
Building background knowledge	"preview what they are getting ready to do."
Introducing concepts	"I use it to introduce and to get points across."
Vocabulary practice	"repetición del concepto en diferentes modalidades" [concept repetition through different modalities].
Concept application/formative assessment	Assign students science performance assessments that they completed in groups using Google Suite applications.
Supporting content and language	Use slide decks with visual and kinesthetic supports for their students.
Supporting sociocultural competence	
Building a strong classroom community	"it lowers the affective filter"
Incorporating students into the curriculum	"estos videos a veces traen palabras que son coloquiales, y ellos se relacionan con esos" [these videos sometimes bring in words that are colloquial, and they relate to those]
Empowering students	"Technology gives them knowledge and knowledge is powerful."
Learning about different cultures	"there are different cultures, and their culture is part of that."

Note. DL= dual language

Supporting Bilingualism and Biliteracy. The first goal of DL education is for students to become bilingual and biliterate (i.e., being able to read and write in both program languages). The DL teachers used several technology tools to support their students' language development in the four language domains (i.e., listening, speaking, reading, and writing). All participants used digital library websites, such as Epic or Scholastic Storyworks, so that their students could access books in English and Spanish. These websites offered a text-to-speech feature for some books, and extension activities including quizzes or student reviews. Tamara and Adriana

sometimes showed videos of "cuentos cortos" [short stories] as an alternative to reading books aloud. Furthermore, Ana and Eleanor had their students work on Smarty Ants, an English literacy application that included mainly phonics and vocabulary instruction. Likewise, Ana and Adriana had their students work on Imagine Español, a Spanish literacy application that encompassed reading, vocabulary, grammar, and syntax instruction along with cultural elements. When describing the use of Imagine Español, Ana stated, "There wasn't a program like that before for native Spanish speakers, so now they get to practice their own language, which I think is awesome… [and] it's a plus for the native English speakers." Adriana attributed her students' growth in Spanish proficiency to this program and their classmates' support; she pointed out:

> [ellos] van reforzando vocabulario, van repasando verbos, sustantivos con medio de las canciones. Ellos aprenden muchas palabras nuevas y para mí es de gran ayuda porque tengo muchos casos de niños que no tienen mucho vocabulario en español y gracias al programa y a muchos de la gente del lado ellos han adquirido mucho vocabulario y hablan más español de cuando yo comencé. Ahora yo puedo decir que me hablan español bien bonito y correcto. [They are reinforcing vocabulary, reviewing verbs and nouns through the songs. They learn many new words and for me it is a great help because I have many cases of children who do not have much vocabulary in Spanish and thanks to the program and many of the classmates around them, they have acquired a lot of vocabulary and speak more Spanish than when I started. Now I can say that they speak Spanish to me very nicely and correctly].

Similarly, Isabela's students sometimes practiced Spanish in This is Language, a website that focused on language acquisition and cultural exposure to different languages. Isabela

mentioned that the listening activities helped her students because “su oído se va ajustando a entender el idioma” [their hearing is adjusting to understanding the language].

In addition, Ana and Eleanor engaged their students with different technology-based activities to support their bilingualism and biliteracy. Eleanor had her students work in groups to conduct research using books and internet sources. Often, she videorecorded her students presenting their findings so that they could practice their oral language skills. Likewise, Ana used the ClassDojo application so that her students could practice reading. She provided her students with a short passage, either in English or Spanish, and her students recorded themselves reading it in ClassDojo. Her students could see their videos and self-assess their reading and watch their classmates’ videos and comment on them. Ana could retrieve the videos and provide her students with feedback as well. Families connected in ClassDojo also had access to the videos. Additionally, Ana used gamified applications such as Blooket and Boom Cards so that her students could practice their reading skills in English and Spanish. For instance, Ana’s students practiced las sílabas [syllables] in Spanish, and vowel patterns or blends in English.

Moreover, Tamara and Isabela’s students practiced Spanish literacy skills at their grade level with interactive exercises online in Liveworksheets or Enciclopedia de Ejemplos. These tools offered a text-to-speech feature and graded students’ work automatically. Tamara employed Liveworksheets frequently because “ahí está todo. Ahí esta la lectoescritura, esta el escuchar. Pueden aplicar el concepto visualmente y también hacen una conexión a la misma vez que lo hacen” [it includes everything: reading and writing, listening. They can apply the concept visually and make connections while they work on it]. Her students worked on the interactive worksheets together as a whole group and enjoyed seeing their scores when the sheet was completed. Meanwhile, Isabela’s students worked on the digital worksheets sometimes during

whole group time and sometimes during independent work. Isabela claimed that the interactive exercises helped her students self-assess and reflect on their own learning.

Supporting Academic Achievement. All participants used different technology tools to support their students' academic achievement. There are four subthemes included within this theme: building background knowledge, introducing concepts, vocabulary practice, and concept application/formative assessment. Each one of these subthemes is further explained next.

Building Background Knowledge. All participants integrated technology into their lessons to build students' background knowledge. For example, Ana stated that she included videos in her lessons to get her students "interested in the topic," and to "preview what they are getting ready to do." In a math lesson where Ana's students had to use tablas de conteo [tally marks graphs] to present and analyze information, she first showed a video where young children were using tally marks to count objects and then created a tabla de conteo to organize the information. Then she built on what the video presented to guide her students through the lesson. Moreover, Eleanor explained that her students use their computers to build their background knowledge:

> when we talked about pollution, for example, I asked them to create commercials and plays and act things out. And one of the things they have to do first is they don't have that prior knowledge so that computer will help them get some of that knowledge that they need to be successful in the activity. So, they and I, we do that all the time. They just Google it.

Introducing Concepts. All participants used videos to introduce new concepts. The tool used most frequently was YouTube. The teachers believed that videos or songs helped students learn new concepts. Tamara often used videos of songs to introduce a particular sílaba [syllable]

during her Spanish language arts lessons. She also showed videos to introduce math and science concepts in Spanish. Eleanor preferred using BrainPOP videos to introduce science topics because "it's research-proven." She stated, "I use it to introduce and to get points across." She added that it explained concepts "in layman's terms. It's easy for students to watch the video and understand afterward what the message was." In addition, most teachers used *Google Slides* to provide instruction. The digital whiteboards made it possible for teachers and students to manipulate the elements in the slides. Therefore, the teachers could model procedures and allow some students to manipulate elements as well as modelling for the rest of the class. Isabela explained that the combination of these tools "permite hacer las presentaciones más interactivas" [enables us to make the presentations more interactive].

Vocabulary Practice. All the participants employed different digital tools for students to practice new vocabulary. The goal was for students to have "repetición del concepto en diferentes modalidades" [concept repetition through different modalities]. For example, Tamara assigned her students math or science vocabulary practice through interactive games in Wordwall by posting the links in Google Classroom. Tamara also used videos with educational songs because she believed that music made learning easier. Often music had a double function in Tamara's classroom: a "brain break" and vocabulary practice. Ana and Adriana's students practiced vocabulary in Spanish with Imagine Español, the Spanish literacy application the district provided.

Concept Application/Formative Assessment. The participants used different digital tools that allowed their students to apply new learning in both English and Spanish. Often, these activities served as formative assessments because the technology tools employed offered teachers data on their students' performance. Some applications, such as Kahoot!, allowed

students to review new content and it gave the teachers information about which students needed extra support or what concepts needed to be retaught. Ana and Adriana's students practiced math in Dreambox, the application purchased by their district. This application was adaptive and created a personalized learning path for students. Teachers could also assign practice on particular math skills.

Tamara and Isabela used interactive digital worksheets for students to practice new concepts. This tool autocorrected students' work, which allowed students to self-reflect on their learning, and provided data to guide teachers' instructional decisions. Isabela also employed built-in quizzes or quick check options from Canvas to assess her students' knowledge. She used the comment feature to provide feedback to her students while she graded the assignments. Eleanor assigned her students science performance assessments that they completed in groups using Google Suite applications. In the example provided in Appendix L, students had to design a compound machine to lift something to a treehouse. Adriana liked using Nearpod to assess her students' mastery level of math concepts and skills because the data collected allowed her to make informed instructional decisions.

Supporting Content and Language. This theme includes codes that overlapped with bilingualism and biliteracy and academic achievement because the teachers' activity goals focused on supporting students' language development so that they could access the content being presented to them or complete a given task. Four out of the five participants prepared their lessons using *Google Slides* so that they could include visual supports for their students. The visual elements clarified concepts or directions steps (see Appendix L). Some elements in the slides were interactive and they allowed teachers to model procedures such as solving a math problem. Students manipulated these elements as well when the teacher called on volunteers to

complete a task. Eleanor did not teach using slide decks, however, she often used Google in the digital whiteboard to find pictures or short videos to help her students understand the meaning of words. In the following interview excerpt, Eleanor explained this:

> For example, we have in our English language words that have multiple meanings and it's very difficult, even for [native] English-speaking people to understand the depth of their definitions. When we talk about pitch and we used that today in our lesson for reading. What's pitch? What does pitch mean? Boom! I can show them right away all the different meanings. I can go on and we can use that to help them understand. You know, like a picture. It's like the pitch to a roof, the pitch in voice. And things like that to get that point across to them.

Other examples included engaging with digital magazines and interactive multimedia presentations. Eleanor's classes had a subscription to Scholastic Storyworks, a multi-genre magazine that includes a digital format as well. She read parts of the printed copies with students, then students selected what part to read next in groups in the digital version. Eleanor claimed that the digital copy was more engaging because it had more options such as animations and text-to-speech features. Frequently, Ana created activities using *Nearpod*. I once observed her make one for students to learn about Benjamin Franklin's contributions. She attached text and video to it. She recorded her voice reading the written directions so that those who needed help reading could listen to the recording. At the end, students had to respond to a prompt and Ana allowed them to choose from writing using the stylus, typing, or recording their voice. Ana included a sentence stem for her students to use in their responses as well. Three of the participants also reported their students attending virtual field trips, which were usually related to social studies or science standards. These were very interactive, so students remained engaged.

Adriana recalled that her students “contestaron, siguieron instrucciones y estaban emocionados viendo todo” [answered questions, followed directions and they were excited to see everything].

Supporting Sociocultural Competence. All participants used different technology tools to develop their students’ sociocultural competence. There are four subthemes included within this theme: building a strong classroom community, incorporating students into the curriculum, empowering students, and learning about different cultures. Each one of these subthemes are further explained next.

Building a Strong Classroom Community. The participants believed that technology could be used to support the building of a strong classroom community because it helped students “feel more comfortable.” For example, Eleanor explained that reading applications that included text-to-speech features or allowed students to change the language from English to Spanish enabled students to participate in reading when otherwise they would not be able to. She added that those special features “lower[ed] their affective filter,” therefore, students were willing to try and felt comfortable reading. In addition, Eleanor’s students often worked in groups to do research or complete performance assessments using books, search engines, Google Docs, or Google Drawings. She recalled a research project during Women’s Week, in which her students researched women of different cultural backgrounds who made important contributions. She stated that her students enjoyed the process, and they were able to see that “anybody can succeed.” Eleanor also showed YouTube videos to teach about values; she explained, “we can learn perseverance. We can learn how we have manners. We can learn just a wealth of things that socially we really need in this world.” Sometimes, Eleanor randomly played encouraging songs for her students to motivate them to get started on a task or continue working.

Incorporating Students Into the Curriculum. Tamara purposely included sources of video or audio of Spanish speakers from different countries because she wanted her students to have exposure to different accents and dialects. She explained her reasoning in this interview excerpt:

> Porque yo escojo videos que demuestran diferentes culturas, donde los niños pueden escuchar diferentes acentos… entonces ellos se identifican con palabras que tienen en su cultura familiar o de otros países, entonces yo creo que les desarrolla un sentido de empatía el escuchar la misma palabra en diferentes acentos. Ellos pueden entender que no todo el mundo habla igual, aunque estén diciendo lo mismo. En este salón yo tengo muchos niños de muchos países: tengo Colombia, Ecuador, México, Puerto Rico, Honduras. Tengo niños de Panamá. So, entonces todos usan a veces diferentes vocablos para referirse a una sola cosa. Y es importante que yo sienta que ellos son parte de la instrucción. Entonces, yo no conozco las palabras de otros países como en el dialecto local. Entonces, estos videos a veces traen palabras que son coloquiales, y ellos se relacionan con esos [Because I choose videos that demonstrate different cultures, where children can hear different accents... then they identify with words that they have in their familiar culture or from other countries, so I think it develops a sense of empathy for them to hear the same word in different accents. They can understand that not everyone speaks the same way, even if they are saying the same thing. In this classroom I have many children from many countries: I have Colombia, Ecuador, Mexico, Puerto Rico, Honduras. I have children from Panama. So, sometimes they all use different words to refer to the same thing. And it's important that I feel that they are part of the instruction.

> So, I don't know the words from other countries like in the local dialect. So, these videos sometimes bring in words that are colloquial, and they relate to those].

Tamara stated that students heard their dialects and felt proud to be included and reaffirmed. The class often discussed the different ways to name things in Spanish and all were validated.

Empowering Students. Eleanor empowered her students by giving them the freedom to explore and seek knowledge. She claimed, "technology gives them knowledge and knowledge is powerful." If her students wanted to learn about something, they could use search engines to look for information. She explained:

> their computer… is their [best friend], it's their best friend and they have a wealth of knowledge. I don't block any sites on them. If there's a concern, I will, I will do a one-on-one with them, but blocking it, you just block knowledge for them, the path of knowledge. It's all about trust, and they don't abuse it.

Therefore, she claimed that her students were more willing to "take on challenges." Eleanor had access to GoGuardian, a tool that monitors what students are doing on their computers, and she would access it sometimes to check.

Learning About Different Cultures. All the participants believed that technology helped their students realize that "there are different cultures, and their culture is part of that." Eleanor expressed, "they just kind of don't feel threatened anymore… and it's good for self-esteem." The Spanish-immersion teachers used different applications (e.g., YouTube, Imagine Español, Liveworksheets) that exposed students to different Spanish-speaking countries. They thought that was a great way for their students to "visualizar la cultura" [visualize the culture] and listen to "diferentes acentos" [different accents] and dialects. Adriana mentioned that her students particularly enjoyed learning words from the different dialects; she explained, "ellos mismos se

preguntan entre ellos y esta palabra que significa, ellos mismos se contestan porque como somos de diferentes nacionalidades, pues se ayudan entre ellos" [they ask each other what this word means, they answer themselves because since we are from different nationalities, they help one another].

Summary

This chapter explored how and why DL teachers use technology, and the extent to which their use of technology supported the goals of DL guided by Mishra and Koehler's (2006) technological pedagogical content framework, Bunch's (2013) pedagogical language knowledge, Biesta et al.'s (2015) teacher agency framework, and Moersch's (1997) levels of technology implementation framework as the overall conceptual framework for this study. I used a sequential explanatory mixed methods analysis to review the quantitative and qualitative data collected. The quantitative data collected with the survey showed that over 80% of DL teachers frequently or very frequently used the internet/social media to find resources/materials for their units/lessons and to learn about a topic they have to teach. Also, 90% or more of DL teachers reported that they frequently or very frequently use technology to present information and provide diverse and current curriculum resources. Additionally, over 80% of DL teachers indicated that they frequently or very frequently use applications to regularly communicate with parents. Items related to using technology for problem-solving, and items that illustrated a student-centered approach to technology use had lower frequencies (34% or less). Similarly, items that measured technology use for assessment purposes had lower frequencies (49% or less) when compared to those that measured technology use for planning and instruction.

As far as factors that influence DL teachers' use of technology, the quantitative data showed high frequencies (98%) for teachers believing that technology can be an effective

learning tool for students and feeling comfortable working with technology (91%). Moreover, 85% of participants somewhat agreed or strongly agreed that technology allows them to address the goals of DL. The inhibiting factor that received the higher frequency score (85%) was the lack of planning time.

Qualitative data was generated through two semi-structured interviews, two 90-minute observations, and artifacts. DL teachers expressed considering their students when making decisions regarding technology use. The participants employed technology tools because their students enjoyed it, it appealed to their students' competitive drive, it increased their engagement, it developed their autonomy, it benefited them academically and it could adapt to students' proficiency level of skills. Additionally, DL teachers used technology because they believed it was an effective instructional tool. The participants also employed digital tools that were convenient for them. For instance, interactive digital worksheets saved teachers paper copies. Moreover, DL teachers were able to use technology because they had the support of colleagues. Teachers' sense of agency also played a role in participants' use of technology; some enacted their agency, while others felt they were not able to because of contextual factors. Furthermore, the teachers used diverse technology tools because they sought to support the goals of DL of bilingualism and biliteracy, academic achievement, and sociocultural competence. The DL teachers' use of technology was influenced by challenges such as planning and instructional time constraints, lack of resources in the partner language, lack of information technology coach or technician support, district/school mandates, or other issues such as a school's network firewall.

Overall, the DL teachers leverage technology in various ways to support their students' bilingualism and biliteracy. They used technology to support students' academic achievement by

building background knowledge, introducing concepts with comprehensible input, and providing vocabulary practice. Different technology tools were also used to enable students to apply new learning and assess their performance. Often, participants' instructional strategies involving technology entailed supporting both language and content learning. Finally, the DL teachers used technology to develop students' sociocultural competence by building a strong classroom community, incorporating students into the curriculum, empowering students, and teaching about different cultures.

This chapter answered the research questions of this study by presenting the findings on the quantitative and qualitative data collected. Chapter 5 offers a discussion of the findings as they relate to the extant literature and the study's theoretical framework. Lastly, I present the implications of the findings and possible future research directions.

CHAPTER 5

DISCUSSION, IMPLICATIONS, AND RECOMMENDATIONS

In this explanatory sequential mixed methods study I sought to understand how and why dual language (DL) teachers in the U.S. use technology. The purpose of the quantitative phase of this study was to explain the different ways DL teachers use technology and what factors influence their use of technology. The purpose of the qualitative phase of this study was to explore DL teachers' decision-making process when using technology and to what extent their use of technology supported the goals of bilingualism and biliteracy, academic achievement, and sociocultural competence. This study was guided by the following research questions:

- Overall R.Q.: How and why do DL teachers use technology?
- Quantitative R.Q.1: In what ways do DL teachers use technology?
    - 1a: In what ways do DL teachers use technology for planning?
    - 1b: In what ways do DL teachers use technology for instruction?
    - 1c: In what ways do DL teachers use technology for assessment?
    - 1d: In what other ways do DL teachers use technology?
- Quantitative R.Q.2: What factors influence teachers' use of technology?
- Qualitative R.Q.1: How do DL teachers describe their decision-making when using technology?
- Qualitative R.Q.2: To what extent do DL teachers use technology to support the goals of DL?

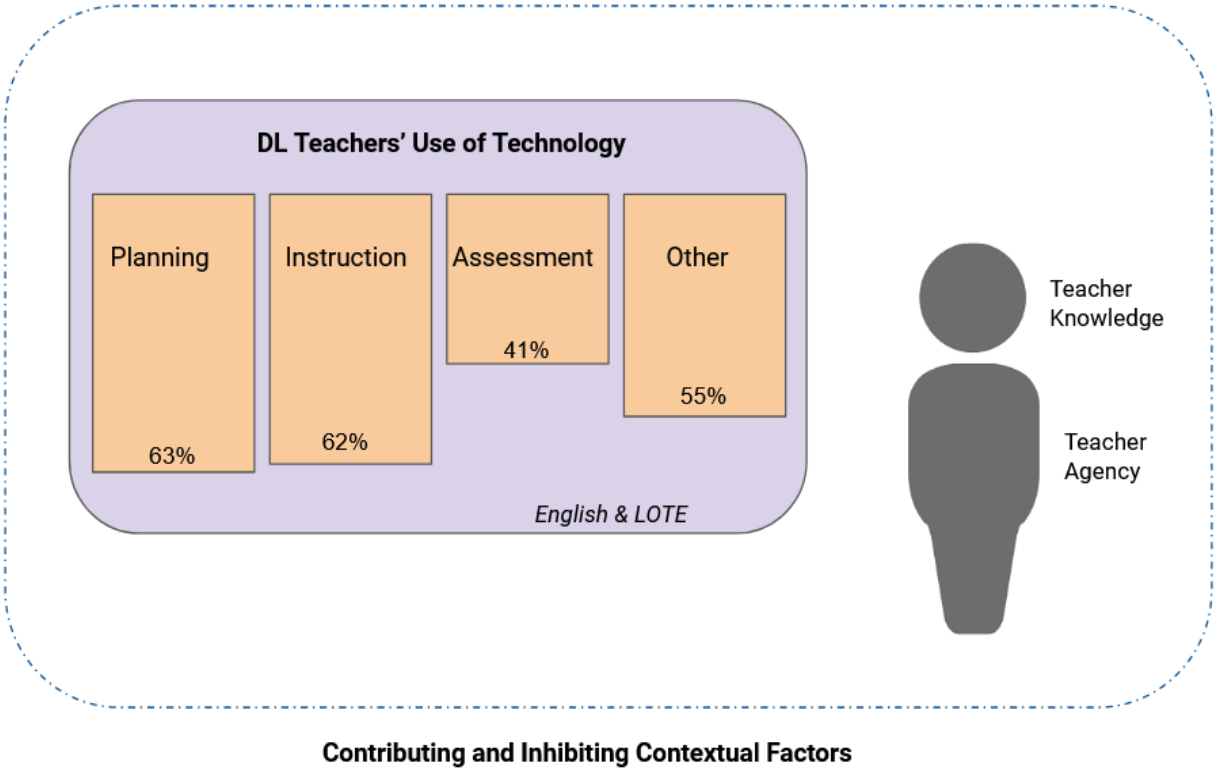
The research findings provide practical and research implications on how DL teachers can use technology to support the goals of DL, how to capitalize on contributing factors that enhance DL teachers' use of technology, and how to moderate inhibiting factors that hinder DL teachers' effective use of technology. This chapter begins with a discussion of the major findings of this study as they relate to the extant literature and theoretical framework. Then, I present the study's implications and recommendations for future research. Lastly, I provide a final conclusion.

Discussion of Major Findings

For this study, I employed an explanatory sequential mixed method design because it allowed me to gain a more comprehensive understanding of how and why DL teachers use technology. Through quantitative data, I gained a general understanding of the different ways DL teachers use technology and the factors that influence such use. Meanwhile, the qualitative strand helped me understand why DL teachers use technology a certain way by exploring selected participants' perspectives in more detail. Therefore, the most significant outcomes of this study were the different ways DL teachers used technology, the contributing and inhibiting contextual factors that influenced their use of technology, and the agency teachers enacted in their decision-making. Figure 6 represents the relationship between the major findings of this study. Following the figure, I provide a discussion of each of the major findings.

Figure 6

Representation of Major Findings



Note. DL= dual language; LOTE= language other than English.

The purple box in Figure 6 represents how DL teachers used technology in English and the language other than English. The orange rectangles representing DL teachers' use of technology are different sizes because they illustrate that DL teachers mostly used technology for instruction and planning, whereas they used it less for assessment and other tasks. The percentages inside each rectangle are the means of the items' frequencies measuring each survey subcategory: planning, instruction, assessment, and other uses. The outside dotted line represents the contributing and inhibiting contextual factors (i.e., available supports and access to resources that influenced the way DL teachers used technology). These contextual factors also affected DL

teachers' agency, which influenced how DL teachers used technology. DL teachers' knowledge also impacted their agency and technology use.

The Ways DL Teachers Use Technology

Most DL teachers reported using the internet (e.g., Google, YouTube) or social media (e.g., TikTok, Facebook) to learn about a topic they have to teach, to gather resources/materials for their lessons, and to learn new teaching strategies. Moreover, DL teachers used digital tools to create or adapt learning experiences that were tailored to students' needs. For example, when Ana created *Nearpod* social studies activities for her students, she supported their language development by recording her voice to read the directions to them, including videos and images, and allowing her students to respond to prompts by drawing, typing, recording their voice, or using a stylus to write. Additionally, Spanish-immersion teachers frequently had to adapt lesson materials by translating them into Spanish or by finding similar resources available in Spanish. Currently, no other research studies have focused on how teachers use technology for planning in DL settings. This study's findings can enhance DL teachers' practices by making their planning more efficient.

This mixed methods study affirmed and expanded other studies' findings regarding the ways DL teachers used technology for instruction while supporting students' language development, academic achievement, and sociocultural competence. Similar to another study (Patthoff et al., 2021), the quantitative and qualitative data revealed that DL teachers used technology mostly for presenting information and to provide diverse and current curriculum resources in the language they teach. In observations, all the participants used a digital whiteboard, a document camera, a computer, and an internet connection to present information or model procedures for their students during direct instruction while incorporating images and

videos to support their students' content and language learning daily. DL teachers used Google Slides and YouTube videos to build background knowledge and introduce a new concept.

Some DL teachers found managing student learning in digital platforms or virtual environments such as Google Classroom or Canvas helpful to differentiate students' independent work. The Spanish-immersion teachers also assigned students independent work using different applications such as Wordwall, Liveworksheets, Nearpod, and Dreambox so that they could apply or reinforce new concepts or skills. This finding expanded results from two other studies (González-Carriedo & Esprívalo Harrell, 2018; Patthoff et al., 2021), in which DL teachers used game-based digital tools, videos, and digital worksheets to assign independent work to their students. Consistent with previous research (González-Carriedo & Esprívalo Harrell, 2018), participants in this study promoted sociocultural competence using videos to teach about different cultures. In addition, Spanish-immersion teachers ensured that they incorporated digital tools (e.g., Imagine Español, Liveworksheets) that included a variety of Spanish dialects so that students were exposed to different regionalisms.

On the other hand, some of the findings of this study were different from previous research. In other studies (Martínez-Álvarez et al., 2012; Pandya, 2018), DL teachers provided assignments in which their students created digital content, such as autobiographical videos or multimodal compositions to support language development and a positive self-identity. When students engaged in multimodal compositions, they became critical thinkers by taking stances on social justice matters and choosing different mediums (e.g., video, images, text, and music) to make compelling arguments (Pandya, 2018). However, in this mixed methods study, multimodality was mostly used as a method of instruction, and students did not engage in the creation of multimodal compositions. In another study (Mercuri & Ramos, 2014), DL teachers

implemented technology-based integrated biliteracy centers in which students had to compose digital books or create videos to teach math skills. In this mixed methods study, DL teachers rarely assigned work in which their students created digital products. The quantitative survey results showed lower means and frequencies for items related to DL teachers assigning students technology-based activities that were student-centered or included problem-solving. For example, just a few teachers reported having their students use digital tools to produce oral or written language, participate in problem-solving activities with others beyond the classroom, and work in groups to create web-based or multimedia projects. From the qualitative phase, only Eleanor engaged her students in technology-based activities that involved solving real-life problems with Google Suite applications.

Furthermore, other research has shown that multimodality offers innovative ways of instruction, learning, and assessment (Elola & Oskoz, 2017; Pandya et al., 2015). In the case of emergent bilinguals, their languages can also be employed as different modes of multimodality (Smith et al., 2017). Thus, teachers might use digital tools and translanguaging pedagogies to enable their students to become co-creators of knowledge (España, 2016; Martínez-Álvarez, 2017a). When teachers employ translanguaging pedagogies they draw on their whole linguistic repertoire and engage their students' entire linguistic repertoires to support their students' learning (García et al., 2016; García-Mateus & Palmer, 2017). In this study, most DL teachers in the qualitative phase kept the separation of languages, except Eleanor. Although she did not speak Spanish, Eleanor supported her students' comprehension by allowing them to engage with bilingual or Spanish resources (e.g., bilingual/Spanish digital books, Spanish videos, and Spanish websites).

DL teachers can leverage technology to assess their students' learning in different ways. For instance, students can create multimodal compositions using different digital tools (e.g., podcasts, videos, slide decks) in both program languages (Howard et al., 2018; Patthoff et al., 2021). However, in this study, survey results for assessment had lower frequencies and means than results for planning and instruction. Some of the survey items with lower scores included: using technology to assess students' content mastery and language skills, providing formative and summative assessments that encourage students to demonstrate their understanding in nontraditional ways, and transferring what they have learned to a real-world context using diverse digital tools. In the qualitative phase, the data generated provided a few examples of how DL teachers used technology for formative assessment. Eleanor was the only participant who engaged her students in science performance assessments with real-life scenarios in which they worked in groups using Google Drawings or other similar digital tools. Adriana sometimes assigned her students math problems in Nearpod because this allowed her to access her students' data and make informed instructional decisions. Ana frequently had her students record themselves reading in English or Spanish on ClassDojo. Students would self-assess by replaying their videos, and Ana provided feedback on their videos as well.

Likewise, DL teachers mihgt use technology to check for student understanding through interactive digital tools such as student response systems and social media (Howard et al., 2018). In this study, less than half of the survey participants reported using game-based response system tools to reinforce concepts taught. Many of the qualitative participants used Kahoot to review concepts or skills at the end of a unit. In particular, Adriana believed that this was beneficial for her students because they performed better in math unit tests afterward. In addition, some digital tools enable teachers to provide students with immediate feedback (España, 2016). In this study,

less than half of survey respondents indicated using technology to provide timely and constructive feedback to students. From the qualitative participants, Isabela regularly engaged in this practice by using the comment feature in Canvas to provide feedback on her students' work including emojis.

Technology can be a powerful tool in education when it is used efficiently, and students are engaged in research and multimedia production (Moersch, 1997). According to the LoTi framework, high levels of technology efficiency involve technology-based learning experiences in which students have a choice of the content, the process, or the product (LoTi Connection, 2016). Such learning experiences can support the goals of DL because in DL programs instruction should promote students' independence and ownership (Howard et al., 2018). However, similar to the participants in González-Carriedo and Esprívalo Harrell's (2018) study, most DL teachers from the qualitative phase of this mixed methods study, did not feel comfortable using technology for higher-order thinking activities. Nevertheless, it is important to highlight that some inhibiting factors (i.e., limited planning time, lack of relevant professional development) contributed to DL teachers assigning student work in which they were mostly consumers of technology.

DL teachers participating in this study also used technology for other purposes besides planning, instruction, and assessment. They used digital tools to communicate with students' families and participate in professional development. Because of its correlation to students' success, family engagement is a cornerstone of DL education (Howard et al., 2018). Effective DL programs use a variety of applications to communicate with families and provide resources for supporting students' bilingualism. In this study, the survey results showed that a high number of participants used applications to regularly communicate with parents, though, less than half

sent families tips/resources for supporting their children's language development. The elementary DL teachers participating in the qualitative phase used tools such as ClassDojo or Seesaw to communicate with parents regularly. Both of these applications have translating capabilities that ease teacher-parent communication. Conversely, Isabela explained that communication with families was less frequent at the secondary level, and it was usually done by email or telephone.

The quantitative data showed that accessing professional development opportunities by attending webinars and virtual conferences and staying informed about news from the field, was another way that DL teachers used technology. However, less than half of survey respondents indicated using the internet/social media to collaborate with other DL teachers outside of their district. Although in the qualitative phase of this study, there were no examples of DL teachers using technology for formal professional development opportunities such as webinars or virtual conferences, DL teachers did use social media to learn new instructional strategies and gather resources. In addition, Adriana regularly collaborated with colleagues from her home country to collect resources in Spanish.

According to Harris et al. (2009) and Moersch (1997), teachers' level of technology implementation differs, and it is not always efficient because of different contextual factors in their instructional environment. In this study, DL teachers' use of technology was impacted by diverse contextual factors regarding available supports and access to resources. In the next section, I discuss the impact of these factors in more detail.

Contextual Factors That Influence DL Teachers' Use of Technology

Findings from the quantitative survey and qualitative observations and interviews revealed that DL teachers' decision-making about how to use technology was influenced by their school and district contexts. The availability of structural supports such as having an information

technology coach to help with planning for technology integration, a technician to assist with malfunctions, and adequate planning time all affected the ways DL teachers used technology. Access to resources (e.g., materials or applications in English and the partner language) also impacted the way DL teachers used technology. Findings about the availability of structural supports and teachers' access to resources are further explained next.

Availability of Structural Supports. According to Howard et al. (2018), to plan purposefully for instruction including cross-linguistic connections, DL teachers' planning time is critical. DL teachers need time to plan individually and collaboratively. Participants in this study from both quantitative and qualitative phases identified the lack of planning time as their main challenge for technology integration. This probably explains why the survey results showed lower means and frequencies for planning items related to collaborating with colleagues to learn about new digital tools. To provide meaningful instruction, DL teachers should collaborate frequently through meetings, emails, and collaborative online tools (e.g., online planning documents; Howard et al., 2018). This was not the case for partner teachers Adriana and Eleanor. They discussed how their assigned planning time was actually spent in unproductive meetings. Spanish-immersion teachers seemed to have the most difficulty since preparing their lessons was time-consuming. It involved looking for digital resources in Spanish, previewing and curating YouTube videos, and translating their district's resources. These teachers often prepared their lessons on the weekends during their personal time.

As DL teachers teach language through content (e.g., math, science, reading, writing), they need specialized training based on different types of knowledge including *pedagogical content knowledge* (PCK) and *pedagogical language knowledge* (PLK; Bunch, 2013). Since DL teachers are expected to integrate technology regularly to provide relevant learning resources and

experiences for their students (Howard, et al., 2018), they also need *technological pedagogical content knowledge* (TPACK; Mishra & Koehler, 2006). These different types of knowledge should be considered when planning relevant professional development for DL teachers. However, similar to a previous study (Patthoff et al., 2021), only a small number of survey respondents reported receiving professional development for technology integration specific to DL (e.g., content and language skills, partner language resources). None of the participants from the qualitative phase was provided professional development for technology integration particular to DL. Eleanor explained that many teachers in her school were not well prepared to use technology for problem-solving or in ways in which students have a more active role (e.g., research group projects, and multimedia creation). According to Eleanor the training teachers received was not effective because it only focused on curriculum, and it overwhelmed the teachers.

Another structural support that was limited for the DL teachers in this study was the availability of a technology integration coach in their buildings to assist with technology integration ideas. Four out of the five participants of the qualitative phase had an information technology coach in their school, but because of the lack of planning time, they were not able to fully take advantage of this support. Further, most participants reported having technology support in their buildings to assist with troubleshooting, the technician was not always available. For example, Tamara explained that her technician was shared between two schools and Eleanor complained that when technology malfunctioned it was not fixed soon enough, and "teachable moments" were lost. Currently, no previous research addresses how these structural supports affect teachers' use of technology in DL.

Access to Resources. DL programs require quality instructional materials and resources in both program languages in order to support bilingualism and biliteracy (Howard et al., 2018). In this study, a high percentage of DL teachers stated that one of their challenges when integrating technology was the lack of resources in the language they teach. Since 52% of the participants taught in the partner language and 37% taught in both English and the partner language, the lack of resources was mainly in the language other than English. The five DL teachers who participated in the qualitative phase mentioned lacking digital resources in Spanish or having more resources available in English. Spanish-immersion teachers expressed that it was more difficult to find quality resources in Spanish. González-Carriedo and Esprívalo Harrell (2018) also found that the lack of resources in the language other than English made technology integration challenging for teachers in DL contexts.

Three of the participants in the qualitative phase had access to digital resources (e.g., Imagine Español, This is language) for literacy and language development in Spanish. Two of the elementary Spanish immersion teachers also had access to Dreambox, a game-based math practice application. Since their classes received math instruction in Spanish, Dreambox was set up in Spanish. Although Eleanor was the English-immersion teacher, she implemented a translanguaging pedagogy (García et al., 2016) to support her students' understanding in Spanish. One of her favorite tools was BrainPop, but she mentioned that it was "hard to find BrainPop videos in Spanish without a membership." The participants hoped to gain access to more digital resources in Spanish as their program continues to grow.

Teacher Agency. In this mixed methods study, I found that DL teachers' agency played an important role in their decision-making for using technology. Agency symbolizes the "quality of engagement of actors" with their contexts (Biesta et al., 2015, p. 626). Teachers' sense of

agency is shaped by their past experiences which are reflected in their beliefs and their present interaction with their context. Although previous research on technology use in DL does not address the role of teacher agency, some studies examined DL teachers' beliefs and attitudes toward technology. DL teachers believe that technology can enhance student engagement, improve students' language skills (González-Carriedo & Esprívalo Harrell, 2018; Patthoff et al., 2021), and facilitate culture integration in the curriculum (Simonsson, 2004). This study had similar findings as most of the participants believed that technology allowed them to attain the goals of DL of bilingualism and biliteracy, academic achievement, and sociocultural competence.

Teachers' agency is also determined by current contextual demands or situations (Biesta et al., 2015). As DL teachers interacted with their school and district, their sense of agency influenced their decisions. The qualitative data generated showed that DL teachers enacted their agency by making an extra effort, being flexible, and seeking help. The teachers were invested in the success of the DL program and were willing to make an extra effort for the sake of the program and their students by working longer than their contracted hours and taking on extra responsibilities (e.g., curriculum writing, and enrolling students in competitions). Furthermore, the five participants of the qualitative phase had a strong desire to be effective teachers and improve their students' learning experience as much as possible. Therefore, the DL teachers sought help to improve their craft or to gain access to resources. For example, Ana turned to social media to learn new instructional strategies that were content-specific or that supported bilingualism and biliteracy. Tamara advocated for more resources in Spanish by making multiple requests to her district. Some of the DL teachers also enacted their agency by remaining flexible with their districts' curriculum implementation. To better serve the needs of students in DL,

modifications to the curriculum should reflect their context and their families' funds of knowledge (Howard et al., 2018). Integrating students' funds of knowledge fosters a more inclusive and supportive learning community that promotes high academic achievement (García & Kleifgen, 2018).

Nevertheless, there were times when DL teachers felt as if they could not exercise their agency due to challenges that were difficult to overcome. Although Tamara tried to be flexible with curriculum implementation and adjusted her instructional time to allow for Spanish language arts instruction, there were times when she could not accomplish this as effectively. She mentioned that sometimes it was difficult to find time for reading small groups with her afternoon class. Ana wanted her technology integration approach to be more student-centered (e.g., allowing her students to create multimedia products); however, she felt that curriculum constraints restricted her creativity. Ana did not believe that the mandatory applications were beneficial for her students, and she wished she could engage them in other activities, but she stated "I have to do what I'm told." Adriana and Isabela recognized that their technology integration approach was mostly teacher-directed and needed improvement. They wanted to expand their knowledge of effective technology integration and learn how to use more educational digital tools, but their limited planning time was a constraint.

DL teachers participating in this study used technology in a variety of ways to support their students' bilingualism and biliteracy, academic achievement, and sociocultural competence. According to Moersch (1997), technology is used efficiently when it supports instruction and higher-order thinking skills. In the LoTi framework, in higher levels of implementation, technology is used as a tool to identify and solve real-world problems related to an overall concept and extend learning outside of the classroom (e.g., collaborating with experts or

organizations). If DL teachers are to implement technology in more efficient ways, then they need certain supports. I provide my recommendations in this regard in the next section.

Implications for Leadership, Policy, and Practice

According to the *Guiding Principles of Dual Language*, teachers should have "appropriate support at the program level for carrying out their work (e.g., necessary supplies, sufficient individual and joint planning time, administrative support in navigating professional challenges and conflicts, requested professional development opportunities, professional respect, and autonomy)" (Howard, et al., 2018, p. 98). Therefore, based on the findings of this study, I provide four recommendations to assist DL teachers' efforts in using technology more effectively. Table 14 summarizes the findings that support my recommendations, and the extant literature that backs up the recommendations.

Table 14

Recommendations to Support Dual Language Teachers' Efforts

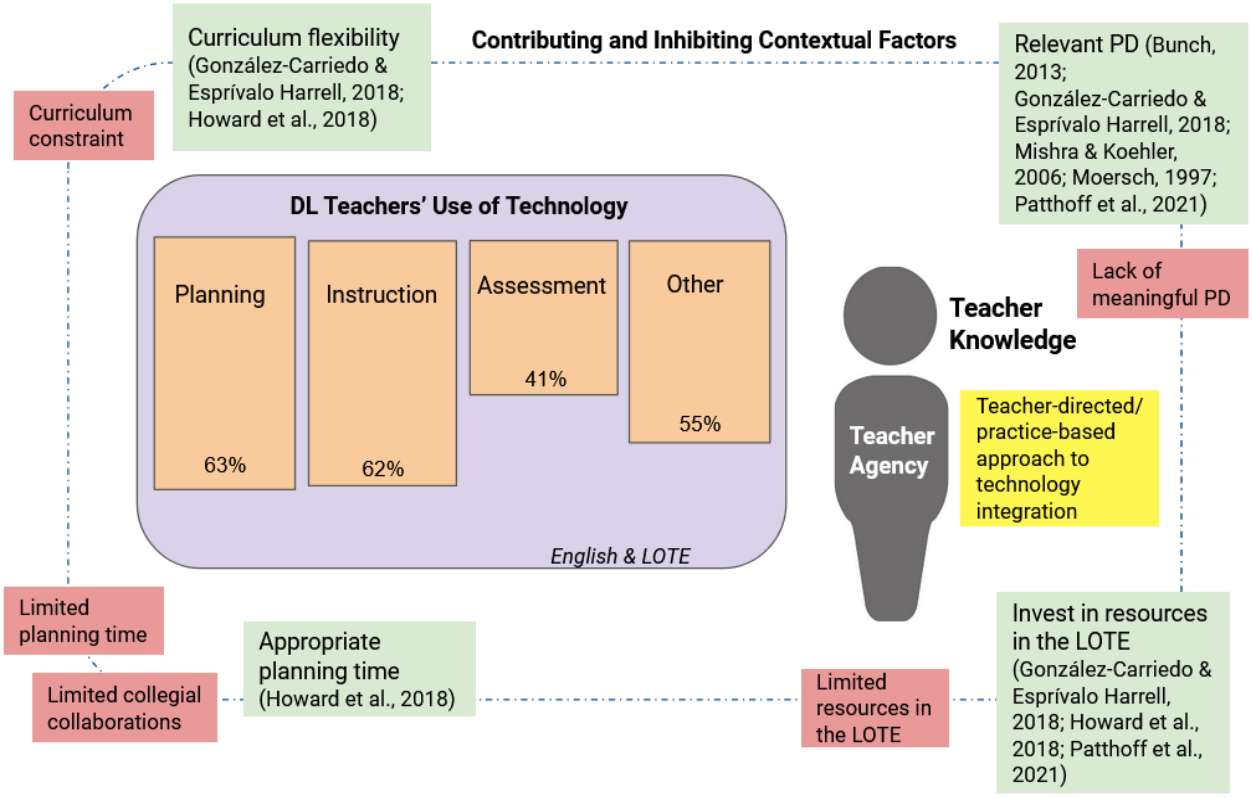
Findings	Related Recommendation	Supporting Literature
Limited planning time Limited collegial collaborations	Provide DL Teachers with appropriate individual and collaborative planning time.	Howard et al. (2018); 2022 pilot study.
Lack of meaningful professional development Mainly a teacher-directed/ practice-based approach to technology integration	Support teachers with professional development that is relevant to dual language settings, and that encourages a student-centered/problem-based technology integration approach.	Patthoff et al. (2021); González-Carriedo & Esprívalo Harrell (2018); Howard et al. (2018); LoTi Connection (2016); Bunch (2013); Mishra & Koehler (2006); Moersch (1997)
Curriculum/instructional time constraint	Allow for curriculum flexibility.	González-Carriedo & Esprívalo Harrell (2018); Howard et al. (2018); 2022 pilot study.
Lack of or limited resources in the LOTE	Invest in resources in the LOTE.	Patthoff et al. (2021); González-Carriedo & Esprívalo Harrell (2018); Howard et al. (2018)

Note. DL= dual language; LOTE= language other than English.

This study's findings showed that DL teachers need certain supports to use technology in a way that reinforces the goals of DL of bilingualism and biliteracy, academic achievement, and sociocultural competence. I recommend that DL teachers be given appropriate planning time, relevant professional development, curriculum flexibility, and more resources in the language other than English. Figure 7 provides a visual representation that summarizes the main findings of this study and the recommendations provided.

Figure 7

Representation of Major Findings and Recommendations



Note. DL= dual language; PD= professional development; LOTE= language other than English.

In Figure 7, the red boxes represent the inhibiting factors that influenced DL teachers' use of technology resulting in a teacher-directed and practice-based technology integration approach (Moersch, 1997), which is represented in the yellow box. The green boxes include the recommendations I make to better support DL teachers including the extant literature that backs them up and the conceptual frameworks that guided this study. Two of the guiding frameworks were *pedagogical language knowledge* (PLK; Bunch, 2013) and *technological pedagogical content knowledge* (TPACK; Mishra & Koehler, 2006) which served as lenses to look at DL

teaches' knowledge and can be a basis for creating relevant professional development. I also used the LoTi framework (Moersch, 1997) as a lens for looking at DL teachers' use of technology. A more detailed explanation of the recommendations follows.

Provide DL Teachers with Appropriate Planning Time

All teachers need appropriate planning time, but in the case of DL teachers, planning time becomes more critically important. DL teachers have to support their students to meet or exceed learning standards for all subjects, while also developing proficiency in two languages (Thomas & Collier, 2012). Therefore, school administrators should provide DL teachers with appropriate time to plan and create materials and assessments, individually and collaboratively (Howard et al., 2018). Participants in both phases of this study identified planning time constraints as one of the main challenges to meaningful technology integration. DL teachers expressed wanting to improve their technology integration approach to include more student-centered technology-based activities but did not have the necessary time to plan for such activities. In addition, some DL teachers wanted to expand their knowledge of digital tools, however, they did not have the necessary time to explore and experiment with new tools. The pilot study I conducted in 2022 had similar findings as the participant expressed the willingness to integrate more technology but lacked the time to plan technology-based activities and to learn new digital tools.

DL teachers also need collaborative planning time so that they can co-create technology-based learning experiences for their students with their colleagues or information technology coaches. Eleanor and Adriana explained that their schedule included a planning period, yet, this time was mostly spent in mandatory meetings, or it was lost due to other teachers' absences. Thus, structures should be put into place to assign planning time, but also to allow teachers to use the time in a way that is beneficial to them. Arrangements are also needed to protect the

designated planning time in case of contingencies and avoid DL teachers losing their planning time due to other teachers' being absent. Because instruction in DL should be purposely planned to embed crosslinguistic connections that support students' content learning and language development (Howard et al., 2018), partner teachers like Eleanor and Adriana need time to plan together to ensure that their lessons build on one another.

Unfortunately, the lack of proper planning time affects Spanish-immersion teachers even more as they need extra time to translate materials or to look for relevant and appropriate resources in Spanish. Consequently, special considerations are needed to better support these teachers. For example, schools could provide teachers with half-day bimonthly planning sessions or quarterly planning days in which they can plan for future units.

Support DL Teachers with Professional Development that is Relevant

DL teachers need specialized training in language education pedagogy, curriculum, assessment, technology, and instructional strategies in order to effectively support their students' bilingualism and biliteracy, academic achievement, and sociocultural competence (Howard et al., 2018). The conceptual framework that guided this study along with findings related to DL teachers' use of technology provide a suitable starting point for creating relevant professional development for DL teachers. Because instruction in DL programs involves teaching language through content, DL teachers require a unique set of skills related to different types of knowledge: language, content, pedagogical, and technological. Those types of knowledge are encompassed in the PLK (Bunch, 2013) and TPACK (Mishra & Koehler, 2006) frameworks. However, to support the success of a DL program, first teachers must be knowledgeable of second language acquisition theory and language development strategies (Howard et al., 2018).

Therefore, developing DL teachers' pedagogical language knowledge (Bunch, 2013) takes precedence over training related to effective technology integration.

Then, DL teachers can participate in professional development that addresses how to integrate technology in a way that is student-centered/problem-based. TPACK (Mishra & Koehler, 2006) and the LoTi framework (LoTi Connection, 2016; Moersch, 1997) can help develop professional development sessions that ensure high levels of efficiency in technology integration. Professional development should address student-centered and problem-based learning experiences in which students identify and solve real-world problems while having a choice in the content, the process, or the product. Other studies have highlighted the importance of technology implementation training specific to DL (González-Carriedo & Esprívalo Harrell, 2018) and training that helps DL teachers move beyond surface-level engagement (Patthoff et al., 2021). Previous research showed that school or district training opportunities were scarce (Patthoff et al., 2021) or focused on how to use digital tools only available in English (González-Carriedo & Esprívalo Harrell, 2018). In this mixed methods study, only 25% of survey respondents indicated they received professional development for technology integration specific to DL (e.g., content and language skills, target language resources). Participants from the qualitative phase mentioned receiving professional development only on how to use tools such as the interactive whiteboards or applications that the district purchased. Eleanor believed that teachers probably used technology mostly for practice drills because they were not properly trained to implement technology for higher-order thinking skills. Eleanor described that she had previously received special training that involved technology integration with math, science, and engineering. Therefore, she was better prepared to engage her students in technology-based student-led investigations and problem-solving tasks.

According to Howard et al. (2018), district and/or school leadership should create a manageable professional development plan to support new and experienced DL teachers. The plan can include professional development retreats with a DL focus, teacher mentoring, and teacher study groups, in which teachers collaborate on creating meaningful lessons including content and language objectives. The professional development plan can include collaboration with other school districts in the state consisting of classroom visits or engaging virtually and taking turns in hosting professional development sessions. State policies that support and facilitate state-wide collaborations are key to ensuring that such collaborations occur. Moreover, state policies such as DL implementation guiding documents should include examples of effective technology integration that promotes the goals of DL and the importance of building teachers' capacity to do so. Professional development about technology integration should include more than logistical procedures or navigating district-purchased applications (Patthoff et al., 2021). Professional development for DL teachers should involve how to use technology for language development and teachers' learning from one another, including observing each other's practices.

Allow for Curriculum Flexibility

In DL programs, technology should be used regularly to provide high-quality, diverse, and relevant curriculum resources in both languages taught (Howard et al., 2018). The DL teachers participating in the qualitative part of this study did not have a specialized curriculum for their DL program. Thus, the teachers had to implement their districts' monolingual curricula, while attending to the goals of the DL program and the needs of their students. The districts' curricula were very comprehensive and prescribed a certain number of minutes for each subject taught including the use of specific applications for math and English literacy practice. The DL

teachers tried to remain flexible when implementing their districts' curricula however, at times they had difficulties with allocating time for Spanish language arts and including creative technology-based activities. Other studies had similar findings, for instance, González-Carriedo and Esprívalo Harrell (2018) found that teachers believed that they did not have enough instructional time to include technology-embedded activities as they only had 90-minute periods with their students. In the pilot study I conducted in 2022, the participant felt that she had so much material to cover from the curriculum that it was very difficult to include technology-based activities in which students created digital products such as multimedia presentations or videos.

Efforts should be made to adopt, adapt, or develop a specialized curriculum that supports the goals of DL. For example, to support the goal of bilingualism and biliteracy, literacy should be taught in both program languages. Therefore, language arts standards related to reading comprehension can be divided between the two languages, while elements unique to each language such as phonemic awareness have to be taught in each language authentically (e.g., teaching reading in Spanish with the syllables and in English with the letter names and sounds). Moreover, if school districts have curriculum policies regarding the number of minutes for each subject matter, it must include an adjustment for the DL program. For instance, literacy minutes should include literacy taught in both program languages while allowing for flexibility for literacy and content integration since cross-disciplinary approaches support language and literacy development (Howard et al., 2018).

If only a monolingual curriculum is available, then teachers should be provided with the flexibility and time to make changes to it as needed. The curriculum should be adjusted to support students' bilingualism and to reflect students' and families' funds of knowledge including relevant and authentic materials in both program languages, instructional strategies that

promote language development, and students' autonomy (Howard et al., 2018). Adjustments to the curriculum should also consider the community the program serves. Successful DL programs have a curriculum that is well aligned with standards and assessment and incorporates higher-order thinking skills infusing technology while accounting for the needs of emergent bilinguals. DL teachers can collaborate to "create new, innovative, technology-based lessons that can be shared with other programs and schools in the district" (Howard et al., 2018, p. 43). I argue that this innovative curriculum could be shared among different districts in the same state since they share the same learning standards in an effort to distribute the workload and facilitate collaboration.

Invest in Resources in the partner language

To effectively integrate technology, DL teachers need to be provided with the proper hardware and software to do so (Patthoff et al., 2021). DL teachers participating in both phases of this study highlighted the need for more resources in the partner language. All participants from the qualitative phase described needing more resources in Spanish as did participants from the González-Carriedo and Esprívalo Harrell's (2018) study, who mentioned having more resources available in English than in Spanish. In DL programs, an extra effort must be made to acquire high-quality materials in the language other than English (Howard et al., 2018). Thus, school districts should allocate funds for the purchasing and development of instructional materials in both languages to ensure that teachers and students have the appropriate resources. Some educational applications are available in a variety of languages but require subscriptions. School districts that host DL programs can invest in applications such as PebbleGo, a digital nonfiction library, or BrainPop, videos covering topics in science, social studies, math, and arts, that are available in both English and Spanish to support students' bilingualism and biliteracy.

While more resources are needed in the language other than English, it is imperative to consider the quality of the applications purchased to ensure investment in appropriate resources. In Patthoff et al.'s (2021) study of how DL teachers used technology to promote mathematical discourse, they found that the lack of technology integration was in part due to school districts providing teachers with applications that only engaged students in rote practice. Nevertheless, it is also important to highlight the overall limited availability of educational digital resources in languages other than English. DL teachers emphasized not having access to sufficient resources in the language other than English compared to the abundance of resources in English. Thus, companies in the educational technology industry and educational content creators must start making more resources available in different languages. As Tamara stated currently "no hay mucho de donde escoger" [there's not much to choose from] when it comes to resources in Spanish. Considering the main findings of this study and its implications, in the next section I provide some recommendations for future research regarding technology use in DL classrooms.

Recommendations for Future Research

In this mixed methods study, I sought to describe the different ways DL teachers use technology, the factors that influence their decision-making when using technology, and how their use of technology supported the goals of bilingualism and biliteracy, academic achievement, and sociocultural competence. To extend the scope of this study, I recommend a quantitative study with a large sample to examine what contextual factors have a higher impact on DL teachers' use of technology. A researcher might use a multiple regression analysis with several predictor variables such as teachers' years of experience, teachers' level of agency, available resources, provided planning time, and provided professional development to assess the strength of the relationship between the dependent and predictor variables. A study of this nature

would inform leadership and policy on what factors to capitalize on to enhance DL teachers' use of technology while supporting the goals of DL.

Due to some limiting factors (e.g., lack of planning time, limited resources in the language other than English, and lack of relevant professional development), most participants in this study integrated technology following a teacher-directed approach with learning activities that were practice-based. Therefore, another researcher can focus on DL teachers' technology integration following a more student-centered approach with problem-based learning experiences (e.g., students creating digital multimedia presentations to address environmental problems, students interviewing a community member, a scientist, or a historian via Zoom to gather data or problem-solving ideas). This research could be done using a qualitative case study approach involving classroom observations, teacher interviews, and artifacts in the form of student samples. A study of this scope has the potential to improve DL teachers' technology practices, and its findings can inform pre-service and in-service teacher training.

In this study, I investigated technology in DL contexts by focusing on DL teachers' use of technology. Thus, there is a need for research focused on how technology integration affects students' academic achievement in content mastery and language proficiency. A study of this nature could have a mixed-methods or qualitative design including observations, along with teacher and student interviews. For instance, a comparative case study could provide insight into what instructional strategies or types of technology-based activities have the potential to increase students' academic achievement. Such a study would improve DL teachers' pedagogies when implementing technology and can in turn provide the basis for relevant training for pre-service and in-service DL teachers. Finally, given the latest development in artificial intelligence (AI) and the different possible uses in education, a new study exploring the use of AI in DL contexts

could make important contributions to the field. For example, a study could explore how diverse AI applications affect teacher planning and instruction, and student learning.

Conclusion

I took on the challenge of researching DL teachers' use of technology about two years ago when I learned about the different benefits technology afforded emergent bilingual students in one of my doctoral classes. That new knowledge made me reflect on my practices as a DL teacher and I realized that I did not implement technology in the most effective ways. This reflection sparked a new curiosity, and I wondered if it was the same case for other DL teachers: Were DL teachers aware of the different technology affordances for emergent bilinguals? Were they aware of how technology tools could be used to support the goals of DL? This study arose out of that questioning.

The limited access to relevant training and resources in Spanish were some of the difficulties I faced as a DL teacher. While completing this study, I was surprised to see the many challenges DL teachers still have to overcome, four years after I left the classroom. The DL teachers participating in this study did not have adequate technology integration training related to DL, nor did they have access to sufficient resources in the partner language of their program. In addition, the DL teachers identified the lack of proper planning time as the most challenging factor for effective technology integration. Consequently, DL teachers enacted their agency by allowing for flexibility in the curriculum implementation, putting on extra effort (usually in the form of extra working hours), and seeking help to improve their practices.

Contextual factors, that is, challenges and supports available, along with DL teachers' enactment of agency impacted their decision-making when using technology; however, they still implemented technology in ways that supported their students' bilingualism and biliteracy,

academic achievement, and sociocultural competence. For instance, DL teachers used applications that built students' reading skills and used videos to introduce concepts or practice vocabulary. One of the participants assigned her students research projects or science performance assessments that they completed using online resources and Google Suite applications. Additionally, DL teachers used digital tools to lower students' affective filter, empower them with knowledge, and teach them about different cultures, including their own.

Considering the main findings of this study, it is imperative that school and district leaders set policies in place to support DL teachers in implementing effective technology practices. Such policies should include adequate teacher individual and collaborative planning time, relevant professional development that is tailored to the needs of the DL program, and curriculum flexibility. Many resources such as state and national agencies, research-based guiding documents, and well-established DL programs, are available to help schools and districts develop policies that support the implementation of a successful DL program. In addition, teacher preparation programs should provide training on how to use technology effectively to promote the goals of DL. Therefore, collaboration between school districts and teacher preparation institutions is key as there should be an alignment between what student-teachers learn and what teachers need to be successful.

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APPENDIX A

EMAIL/SOCIAL MEDIA RECRUITMENT

Hello,

My name is Paola Mendizábal, I'm a Ph.D. student at William & Mary and a dual language educator. I would like to invite you to participate in my research study investigating the different ways dual language teachers use technology and what factors might influence their use of technology.

To participate in this study, you must be a current (2022-2023 school year) dual language teacher. This survey should take about 10-15 minutes to complete.

Participation in this research study is completely voluntary, you may choose not to participate without penalty.

As a participant, you will be asked to complete an online survey. All data will be treated confidentially and stored on a secure server. I will be the only one with access to it.

If you would like to participate in this research study, please click the survey link below and read the consent page carefully.

Survey link:

If you have questions related to the research, please contact me at pgmendizabal@wm.edu.

Thank you for your time and cooperation,

Sincerely,

Paola Mendizábal
Doctoral Candidate
Educational Policy, Planning and Leadership, Curriculum and Learning Design
William & Mary

APPENDIX B

DLTUTS SURVEY ITEMS AND THEIR SOURCES

Item	Item text	Item source
Item 1	Teaching students how to use technology is part of my job.	TTIS
Item 2	Technology can be an effective learning tool for students.	Qual. pilot study
Item 3	I get excited when I am able to show my students a new technology application or tool.	TTIS
Item 4	Technology allows me to address the goals of dual language (bilingualism, biliteracy, academic achievement, and sociocultural competence).	DL guiding principles
Item 5	I feel comfortable working with digital technologies.	TTIS
Item 6	I am confident in my ability to troubleshoot when problems arise while using technology.	TTIS
Item 7	It is mandatory in my school/district that I integrate technology and use specific digital tools (e.g., reading or math applications).	Qual. pilot study
Item 8	Technology support is available in my building to assist with troubleshooting.	TTIS
Item 9	A technology integration coach is available in my building to assist with technology integration ideas.	TTIS
Item 10	I receive professional development for technology integration specific to dual language (e.g., content and language skills, target language resources).	Qual. pilot study
Item 11	One of my challenges for technology integration is the lack of planning time.	LoTi
Item 12	I get anxious when using new technologies because I don't know what to do if something goes wrong.	TTIS
Item 13	I'm not able to implement technology-based activities because I don't have enough time in my instructional day.	Qual. pilot study
Item 14	One of my challenges when integrating technology is the lack of resources in the language I teach.	Qual. pilot study
Item 15	Testing or standardized testing practice makes it difficult to implement creative technology-based activities.	LoTi

Item	Item text	Item source
Item 16	I use the internet to learn about a topic that I have to teach.	Qual. pilot study
Item 17	I use digital tools to create technology-based learning activities for my students.	Qual. pilot study
Item 18	I use the internet/ social media to find resources/materials for my units/lessons.	Qual. pilot study
Item 19	I use technology to create, adapt, and personalize learning experiences that accommodate learner differences and needs.	ISTE Standards
Item 20	I use the internet/social media to learn new teaching strategies.	Qual. pilot study
Item 21	I collaborate with others (e.g., teachers, technology integration coaches) to explore the application of digital tools that improve student learning.	LoTi
Item 22	I use technology to create, adapt, and personalize learning experiences that foster independent learning.	ISTE standards
Item 23	I collaborate and co-learn with my students to discover and use new digital resources and diagnose and troubleshoot technology issues.	ISTE standards
Item 24	I create diverse formative and summative assessments that encourage students to demonstrate their understanding in nontraditional/alternative ways.	DL guiding principles
Item 25	I use technology (e.g., SmartBoard, document camera, projector) to present information.	TTIS
Item 26	I use technology to provide diverse and current curriculum resources (e.g., photos, videos, virtual field trips, primary source materials) in the language I teach.	DL guiding principles
Item 27	I use diverse technology tools to address content standards.	DL guiding principles
Item 28	I manage students' use of technology and student learning in digital platforms, and virtual environments (e.g., *Canvas*, *Seesaw*, *Google Classroom*).	ISTE standards
Item 29	My class uses digital tools to participate in problem-solving activities with others beyond the classroom.	LoTi
Item 30	I use diverse technology tools to address language and literacy standards.	DL guiding principles
Item 31	I assign students technology-based activities that help them produce oral or written language.	DL guiding principles

Item	Item text	Item source
Item 32	I use digital tools (e.g., multimedia, online tutorials, online simulations, videos) to provide comprehensible input.	Qual. pilot study
Item 33	I provide my students with opportunities to work in groups to create web-based or multimedia presentations (e.g., *Prezi*, *PowerPoint*, *Google Slides*, eBooks).	LoTi
Item 34	I empower my students to self-select the most appropriate digital tool to aid them in completing a given task.	LoTi
Item 35	I use technology to provide timely and constructive feedback to students.	ISTE standards
Item 36	I use student-centered performance assessments that involve students transferring what they have learned to a real-world context using diverse digital tools.	LoTi
Item 37	I use technology to assess my students' understanding of content.	Qual. pilot study
Item 38	I use technology to assess my students' language skills.	Qual. pilot study
Item 39	I provide diverse formative and summative assessments that encourage students to demonstrate their understanding in nontraditional/alternative ways.	LoTi
Item 40	I use technology to monitor students' language development and biliteracy progress.	DL guiding principles
Item 41	I use game-based student response system tools (e.g., Kahoot, peardeck, Quizzizz) to reinforce concepts taught.	DL guiding principles
Item 42	I use applications to regularly communicate with parents.	Qual. pilot study
Item 43	I send electronic newsletters to communicate with families.	DL guiding principles
Item 44	I use applications to send families tips/resources for supporting their children's language development.	DL guiding principles
Item 45	I use technology for holding conferences virtually.	Content expert
Item 46	I use technology for professional development purposes (e.g., webinars, virtual conferences, and news from the field).	Qual. pilot study
Item 47	I use the internet/social media to collaborate with other dual language teachers outside of my district.	Survey pilot

APPENDIX C

SURVEY IN QUALTRICS

Start of Block:

Consent form

This survey is being conducted by Paola Mendizábal, a doctoral candidate in Educational Policy, Planning and Leadership, Curriculum and Learning Design at William & Mary.

The purpose of this study is to investigate in what ways dual language teachers use technology and what factors might influence their use of technology.

This survey should take about 10-15 minutes to complete.

Participation in this research study is completely voluntary. If you agree to be in the study, but later change your mind, you may drop out at any time without question or comment.

To participate in this study, you must be a current (2022-2023 school year) dual language teacher. If you do not meet these criteria, please do not complete this survey.

There are no known risks and/or discomfort associated with participation in this study.

All survey responses received will be treated confidentially and stored on a secure server. The data collected will not be used to evaluate you and only the researcher will have access to it. Your name and other identifying information will only be known to the researcher. However, you should also know that The College of William and Mary Institutional Review Board (IRB) may inspect study records, but these reviews will only focus on the researchers and not on your responses or involvement. The IRB is a group of people that reviews research studies to make sure they are safe for participants.

If you have any questions or concerns about this research, you may contact the principal investigator, pgmendizabal@wm.edu, 646-821-1734; my faculty advisor, Dr. Mark Hofer, 757-221-1713, mjhofe@wm.edu; or Dr. Thomas Ward, chair of the Education Internal Review Committee (EDIRC), 757-221-2358, tjward@wm.edu.

By checking the "I agree to participate" response below, you indicate your voluntary agreement to participate in this study.

- ○ Yes, I agree to participate (1)
- ○ No, I decline (2)

Skip To: End of Survey If This survey is being conducted by Paola Mendizábal, a doctoral candidate in Educational Policy, P... = No, I decline

Start of Block: Factors that influence TUT

Contributing Factors

Please indicate your level of agreement with the following statements.
When finished, please click the dark green arrow on the bottom to move to the next section.

	Strongly agree (5)	Somewhat agree (4)	Neither agree nor disagree (3)	Somewhat disagree (2)	Strongly disagree (1)
Teaching students how to use technology is part of my job.	○	○	○	○	○
Technology can be an effective learning tool for students.	○	○	○	○	○
I get excited when I am able to show my students a new technology application or tool.	○	○	○	○	○
Technology allows me to address the goals of a dual language (bilingualism, biliteracy, academic achievement, and sociocultural competence).	○	○	○	○	○
I feel comfortable working with digital technologies.	○	○	○	○	○
I am confident in my ability to troubleshoot when problems arise while using technology.	○	○	○	○	○
It is mandatory in my school/district that I use certain digital tools (e.g., reading or math applications).	○	○	○	○	○
Technology support is available in my building to assist with troubleshooting.	○	○	○	○	○
A technology integration coach is available in my building to assist with technology integration ideas.	○	○	○	○	○
I receive professional development for technology integration specific to dual language (e.g., content and language skills, target language resources).	○	○	○	○	○

Page Break

Inhibiting factors

Please indicate your level of agreement with the following statements.
When finished, please click the dark green arrow on the bottom to move to the next section.

	Strongly agree (5)	Somewhat agree (4)	Neither agree nor disagree (3)	Somewhat disagree (2)	Strongly disagree (1)
One of my challenges for technology integration is the lack of planning time.	○	○	○	○	○
I get anxious when using new technologies because I don't know what to do if something goes wrong.	○	○	○	○	○
I'm not able to implement technology-based activities because I don't have enough time in my instructional day.	○	○	○	○	○
One of my challenges when integrating technology is the lack of resources in the language I teach.	○	○	○	○	○
Testing or standardized testing practice makes it difficult to implement creative technology-based activities.	○	○	○	○	○

End of Block: Factors that influence TUT

Start of Block: Teacher Use of Technology

Planning

Please indicate the frequency with which you engage in the following activities.
When finished, please click the dark green arrow on the bottom to move to the next section.

	Very Frequently (5)	Frequently (4)	Occasionally (3)	Rarely (2)	Never (1)
I use the internet to learn about a topic that I have to teach.	○	○	○	○	○
I use digital tools to create technology-based learning activities for my students.	○	○	○	○	○
I use the internet/social media to find resources/materials for my units/lessons.	○	○	○	○	○
I use technology to create, adapt, and personalize learning experiences that accommodate learners' differences and needs.	○	○	○	○	○
I use the internet/social media to learn new teaching strategies.	○	○	○	○	○
I collaborate with others (e.g., teachers, technology integration coaches) to explore the application of digital tools that improve student learning.	○	○	○	○	○
I use technology to create, adapt, and personalize learning experiences that foster independent learning.	○	○	○	○	○
I collaborate and co-learn with students to discover and use new digital resources and diagnose and troubleshoot technology issues.	○	○	○	○	○
I create diverse formative and summative assessments that encourage students to demonstrate their understanding in nontraditional/alternative ways.	○	○	○	○	○

Instruction

Please indicate the frequency with which you engage in the following activities.
When finished, please click the dark green arrow on the bottom to move to the next section.

	Very Frequently (5)	Frequently (4)	Occasionally (3)	Rarely (2)	Never (1)
I use technology (e.g., SmartBoard, document camera, projector) to present information.	○	○	○	○	○
I use technology to provide diverse and current curriculum resources (e.g., photos, videos, virtual field trips, primary source materials) in the language I teach.	○	○	○	○	○
I use diverse technology tools to address content standards.	○	○	○	○	○
I manage students' use of technology and student learning in digital platforms or virtual environments (e.g., CANVAS, Seesaw, Google Classroom).	○	○	○	○	○
My class uses digital tools to participate in problem-solving activities with others beyond the classroom.	○	○	○	○	○
I use technology tools to address language and literacy standards.	○	○	○	○	○
I assign students technology-based activities that help them produce oral or written language.	○	○	○	○	○
I use digital tools (e.g., multimedia, online tutorials, online simulations, videos) to provide comprehensible input.	○	○	○	○	○
I provide my students with opportunities to work in groups to create web-based or multimedia presentations (e.g., Prezi, PowerPoint, Google Slides, eBooks).	○	○	○	○	○
I empower my students to self-select the most appropriate digital tool to aid them in completing a given task.	○	○	○	○	○

Assessment

Please indicate the frequency with which you engage in the following activities.
When finished, please click the dark green arrow on the bottom to move to the next section.

	Very Frequently (5)	Frequently (4)	Occasionally (3)	Rarely (2)	Never (1)
I use technology to provide timely and constructive feedback to students.	○	○	○	○	○
I use student-centered performance assessments that involve students transferring what they have learned to a real-world context using diverse digital tools.	○	○	○	○	○
I use technology to assess my students' understanding of content.	○	○	○	○	○
I use technology to assess my students' language skills.	○	○	○	○	○
I provide different formative and summative assessments that encourage students to demonstrate their understanding in nontraditional ways.	○	○	○	○	○
I use technology to monitor students' language development and biliteracy progress.	○	○	○	○	○
I use game-based student response system tools (e.g., Kahoot, peardeck, Quizzizz) to reinforce concepts taught.	○	○	○	○	○

End of Block: Teacher Use of Technology

Start of Block: Other

Other

Please indicate the frequency with which you engage in the following activities.
When finished, please click the dark green arrow on the bottom to move to the next section.

	Very Frequently (5)	Frequently (4)	Occasionally (3)	Rarely (2)	Never (1)
I use applications to regularly communicate with parents.	○	○	○	○	○
I send electronic newsletters to communicate with families.	○	○	○	○	○
I use applications to send families tips/resources for supporting their children's language development.	○	○	○	○	○
I use technology for holding conferences virtually.	○	○	○	○	○
I use technology for professional development purposes (e.g., webinars, virtual conferences, and news from the field).	○	○	○	○	○
I use the internet/social media to collaborate with other dual language teachers outside of my district.	○	○	○	○	○

End of Block: Other

Start of Block: Demographics

D1 How many years of teaching experience do you have including the 2022-2023 school year?

- ○ less than 5 years (1)
- ○ 5-9 years (2)
- ○ 10-20 years (3)
- ○ more than 20 years (4)

D2 How many years of teaching experience do you have in dual language including the 2022-2023 school year?

- ○ less than 5 years (1)
- ○ 5-9 years (2)
- ○ 10-20 years (3)
- ○ more than 20 years (4)

D3 Please indicate your current role in your dual language program:

- ○ I teach in English (1)
- ○ I teach in the partner language (2)
- ○ I'm a self-contained teacher (teach in both program languages) (3)

D4 Please indicate your current grade level in dual language

- ○ PreK-2nd (1)
- ○ 3rd-5th (2)
- ○ Middle School (3)
- ○ High School (4)

D5 What is the partner language in your dual language program?

- ○ Spanish (1)
- ○ Chinese (2)
- ○ French (3)
- ○ Japanese (5)
- ○ German (4)
- ○ Other (6)

D6 What is the structure of your dual language program?

- ○ the whole school is a dual language (1)
- ○ dual language is a strand within a school (only a few classes per grade level are dual language) (2)

D7 What statement best describes your classroom's digital infrastructure?

- ○ one-to-one laptop/mobile device (1)
- ○ access to a shared laptop/mobile device cart (2)
- ○ access to a shared computer lab (3)
- ○ BYOD (Bring your own device) (4)
- ○ Other (5)

End of Block: Demographics

Start of Block: Invitation to Qual

Skip A limited number of participants will be invited to also participate in follow-up interviews and observations. Are you willing to participate in these?

- ○ Yes, sure. (1)
- ○ No, thank you. (2)

Skip To: End of Survey If A limited number of participants will be invited to also participate in follow-up interviews and... = No, thank you

Skip To: info If A limited number of participants will be invited to also participate in follow-up interviews and... = Yes, sure.

info

Thank you, please provide **your name and email**. You will be contacted within a week to confirm your participation in the second part of this study.
Your name and email will remain confidential.

_____

End of Block: Invitation to Qual

APPENDIX D

SURVEY CONSENT FORM

This survey is being conducted by Paola Mendizábal, a doctoral candidate in Educational Policy, Planning and Leadership, Curriculum and Learning Design at William & Mary.

The purpose of this study is to investigate in what ways dual language teachers use technology and what factors might influence their use of technology.

This survey should take about 10-15 minutes to complete.

Participation in this research study is completely voluntary. If you agree to be in the study, but later change your mind, you may drop out at any time without question or comment.

To participate in this study, you must be a current (2022-2023 school year) dual language teacher. If you do not meet these criteria, please do not complete this survey.

There are no known risks and/or discomfort associated with participation in this study.

All survey responses received will be treated confidentially and stored on a secure server. The data collected will not be used to evaluate you and only the researcher will have access to it. Your name and other identifying information will only be known to the researcher. However, you should also know that The College of William and Mary Institutional Review Board (IRB) may inspect study records, but these reviews will only focus on the researchers and not on your responses or involvement. The IRB is a group of people that reviews research studies to make sure they are safe for participants.

If you have any questions or concerns about this research, you may contact the principal investigator, pgmendizabal@wm.edu, 646-821-1734; my faculty advisor, Dr. Mark Hofer, 757-221-1713, mjhofe@wm.edu; or Dr. Thomas Ward, chair of the Education Internal Review Committee (EDIRC), 757-221-2358, tjward@wm.edu.

By checking the “I agree to participate” response below, you indicate your voluntary agreement to participate in this study.

APPENDIX E

INVITATION TO THE SECOND PART OF THE STUDY

Dear X,

Thank you so much for completing the first part of this study on dual language teachers' use of technology. The purpose of this study is to investigate the different ways dual language teachers use technology and the factors that might influence their use of technology. According to your survey response, you have agreed to participate in the second part of this study.

The second part of this study will consist of two one-on-one interviews of about an hour each, 2-3 scheduled observations of about 90 minutes each, and the collection of artifacts such as lesson plans and students' work samples. Interviews will be audio-recorded and scheduled at your convenience. In the first interview, I will ask questions that follow up on your survey responses. In the second you will be asked follow-up questions after lessons/activities observation. There will be a total of 2-3 scheduled observations of about 90 minutes each; which will be video-recorded. To protect students' identities the camera will be focused on you, the teacher.

Please reply to this email with several dates and times that you can be available to set up the first interview. Once I select a time, I will send you a calendar invitation.

Thank you again for your time,

Sincerely,

Paola Mendizábal
Doctoral Candidate
Educational Policy, Planning and Leadership, Curriculum and Learning Design
William & Mary

APPENDIX F

LETTER TO SCHOOL DISTRICT RESEARCH ADMINISTRATOR

Dear X,

My name is Paola Mendizábal, I'm a Ph.D. student at William & Mary and a dual language educator. I'm conducting research on the different ways dual language teachers use technology and the factors that might influence the decision-making process when using technology.

I will be conducting the study under the supervision of my professor, Mark Hofer. A few of the teachers in your district participated in the first phase of this study filling out a survey and have indicated interest in being part of the second phase of the study. I'm writing to you to formally ask permission to conduct research in school X.

The data generation for this study will begin as early as February 2023 and may continue through March 2023. Data collection will consist of two one-on-one interviews of about an hour each, 2-3 scheduled observations of about 90 minutes each, and the collection of artifacts such as lesson plans and students' work samples. Observations will be video-recorded, and to protect students' identities the camera will be focused on the teacher. Interviews will be audio-recorded. Both interviews and observations will be scheduled at the teachers' convenience.

Responses to interviews and data collected in observations will be confidential. Personal information will be protected to the maximum extent allowable by law. The data collected will not be used to evaluate the teachers or the program, and only researchers will have access to it.

Teachers' participation in this research is, of course, voluntary. There is not any known risk for participation. As a fellow dual language educator, I would like to offer a workshop or professional development opportunity to the participating teachers or the school district as a token of my appreciation.

Thank you for assisting me in my educational endeavors. I genuinely appreciate your time. If you require additional information or have questions, please contact me at the email listed below.
Sincerely,

Paola Mendizábal
Doctoral Candidate
Educational Policy, Planning and Leadership, Curriculum and Learning Design
William & Mary

APPENDIX G

QUALITATIVE STRAND CONSENT FORM

Thank you for completing the first part of this study on dual language teachers' use of technology. According to your survey response, you have agreed to participate in the second part of this study investigating the different ways dual language teachers use technology and the factors that might influence their use of technology.

This study is being conducted by Paola Mendizábal, a doctoral candidate in Educational Policy, Planning and Leadership, Curriculum and Learning Design at William & Mary.

This study involves participating in two one-on-one interviews of about an hour each. They will be audio-recorded and scheduled at your convenience. In the first interview, I will ask questions that follow up on your survey responses. In the second you will be asked follow-up questions after lessons/activities observation. There will be a total of 2-3 scheduled observations of about 90 minutes each; which will be video-recorded. To protect students' identities the camera will be focused on you, the teacher.

Participation in this research study is completely voluntary. If you agree to be in the study, but later change your mind, you may drop out at any time without question or comment. There are no penalties or consequences of any kind if you decide that you do not want to participate. There are no known risks and/or discomfort associated with the participation in this study.

The confidentiality of your personal information will be protected to the maximum extent allowable by law. The data collected will not be used to evaluate you and only the researcher will have access to it. Your name and other identifying information will only be known to the researcher. A summary of the results of the study will be sent to you once they are complete.

If you have any questions or concerns about this research, you may contact the principal investigator, pgmendizabal@wm.edu, 646-821-1734; my faculty advisor, Dr. Mark Hofer, 757-221-1713, mjhofe@wm.edu; or Dr. Thomas Ward, chair of the Education Internal Review Committee (EDIRC), 757-221-2358, tjward@wm.edu.

By checking the "I agree to participate" response below, signing and dating this form, you indicate your voluntary agreement to participate in this study. A copy of this consent form will be given to you to keep.

☐ I agree to participate.

☐ I don't agree to participate.

SIGNATURES:

Participant: _____ Date: _____

Researcher: _____ Date: _____

APPENDIX H

INITIAL INTERVIEW PROTOCOL

Date: Place:

Time of interview:

Interviewer: Interviewee:

(Explain the purpose of the study, data collection, confidentiality, and how long the interview will take)

[start recording]

Questions:

1. In the survey you stated that technology was an effective learning tool. Can you tell me why you think it is an effective tool or how can it be an effective tool?
2. In the survey you stated that technology helps you support the goals of dual language. How so? Can you elaborate on that?
3. Tell me about how you use technology for planning.
4. Tell me about how you use technology to facilitate instruction.
5. Tell me about how you use technology to assess your students.
6. What are some other ways in which you use technology?
7. What factors, if any, contribute to you integrating technology in your instruction?
8. What factors, if any, inhibit you from integrating technology into your instruction?
9. What kind of supports do you need to integrate technology effectively and more regularly? *Assuming they are not able to.

(Thank the participants for their time and cooperation. Assure them of the confidentiality of the responses).

APPENDIX I

SECOND INTERVIEW PROTOCOL

Date: Place:

Time of interview: Interviewee:

(Explain confidentiality, and how long the interview will take)

[start recording]

Questions:

1. I saw you used _____ (digital tool) to introduce/teach _____ (concept/skill). Why did you decide to use that activity? * repeat questions for other examples observed if needed.
    a. How did that enhance your students' learning?
    b. How did that support your students' mastery of the content?
    c. How did that support your students' language development?
    d. How did that contribute toward sociocultural competency?
2. Why did you decide to use _____ (digital tool)?
    a. How did it enhance your students' learning?
    b. How did it support your students' mastery of the content?
    c. How did it support your students' language development?
    d. How did it contribute toward sociocultural competency?
3. How do the technology tools that you use contribute toward sociocultural competency? * if not previously answered

(Thank the participants for their time and cooperation. Assure them of the confidentiality of the responses).

APPENDIX J

OBSERVATION PROTOCOL

Place: Time:

Observer: Role of observer:

Length of observation:

R.Q.1: To what extent do DL teachers use technology to support the goals of dual language (bilingualism, biliteracy, academic achievement, sociocultural competence?

Time Stamp	Descriptive Notes- instances with technology	Reflective Notes

(Thank the participants for their time and cooperation. Assure them of their confidentiality).

APPENDIX K

VISUAL DISPLAY OF THEMES AND SUBTHEMES

Decision-making- why?

Ss interest, consideration: enjoyment, competition, engagement, autonomy, academic benefits, differentiation	**Supporting bilingualism/biliteracy**
teacher agency: extra effort, flexibility, seeking help, barriers to excising agency	**Supporting Academic achievement:** building background knowledge, introducing concepts, vocabulary practice, concept application/formative assessment
because it's convinient for Teachers	**Supporting content and language**
Teacher beliefs	**Supporting Sociocultural competence:** building a strong classroom community, incorporating students into the curriculum, empowering students, learning about different cultures

Contributing factors	**Inhibiting factors**
collegial supports	planning time constraint
	instructional time constraint
	Lack of resources in the LOTE
	Lack of ITC/Tech support
	Other Issues
District/school mandates	

APPENDIX L

ARTIFACTS

Figure A1

Example of a Personalized Slide Used by Ana

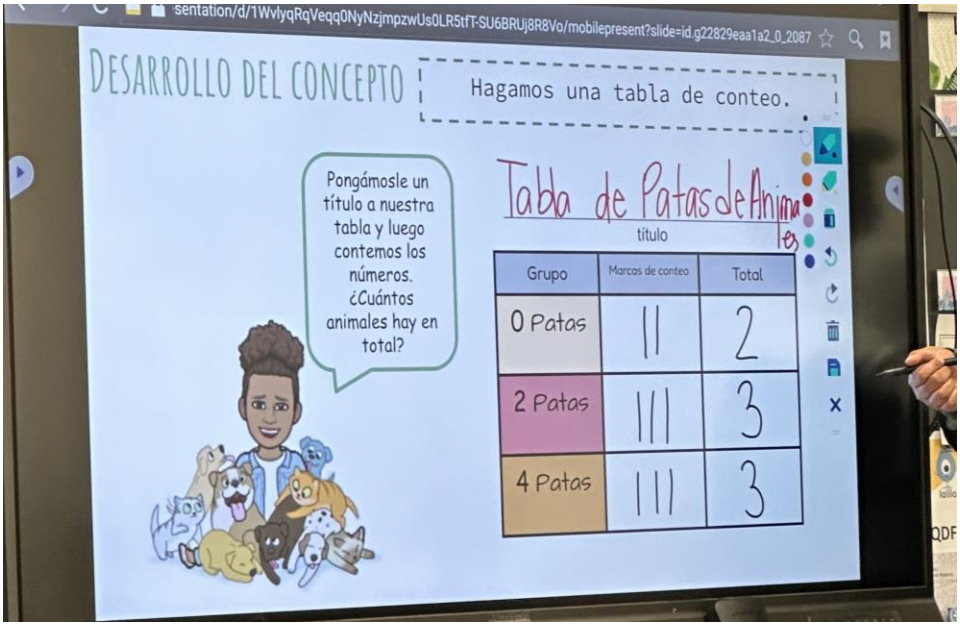

Figure A2

Example of a Slide With Interactive Components Used by Tamara

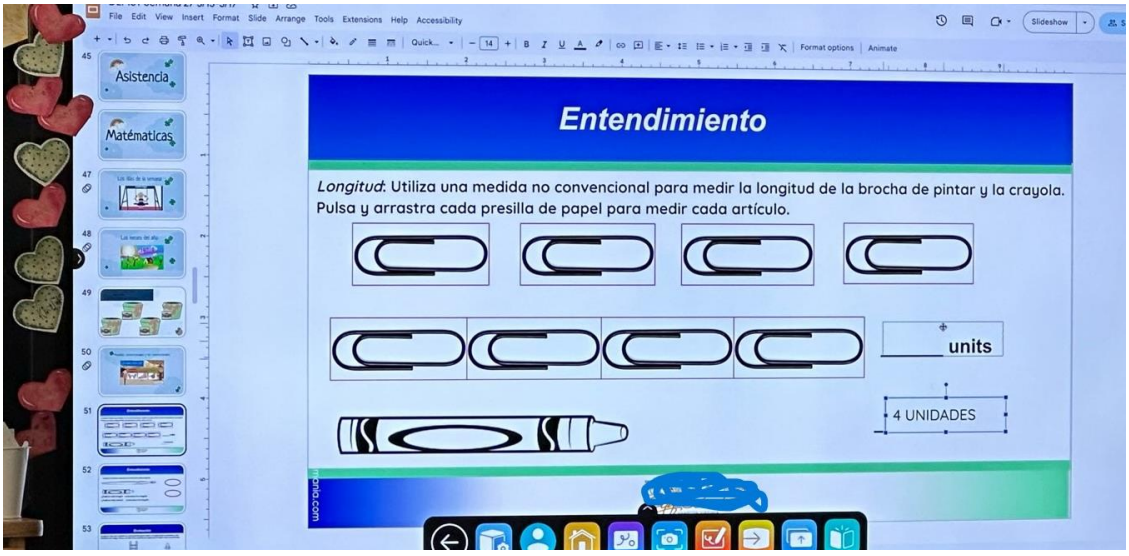

Figure A3

Example of a Slide With Visual Directions Used by Ana

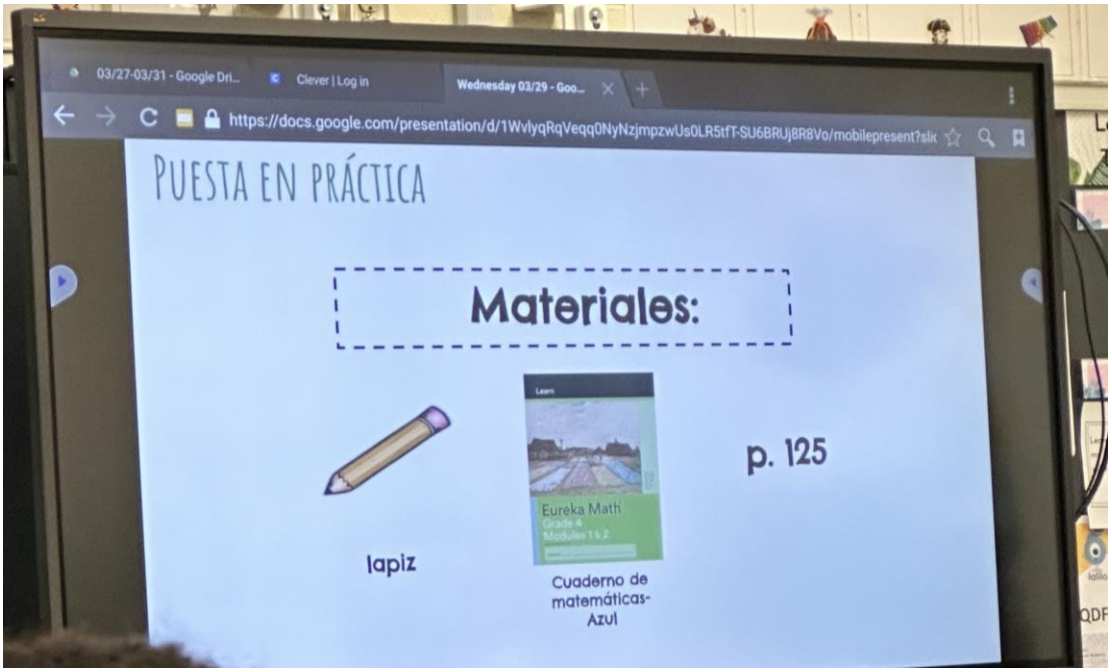

Figure A4

Example of a Simple Machines Performance Assessment Using Google Drawing

APPENDIX M

DIGITAL TOOLS USED BY DL TEACHERS IN THIS STUDY

Digital tool	Description	How DL teachers used it
YouTube	Video streaming online platform	Introducing concepts, brain breaks, vocabulary songs
Google Slides	Online slideshows	Presenting information, and modeling
Liveworksheets	Online self-correcting and interactive worksheets	Concept application: phonics, orthography, grammar
Prodigy	Website for gamified math practice.	Practice math skills
Google Classroom	Learning management system	Post student work (website links)
*Canvas	Learning management system	Manage classwork, post assignments, and teacher-student interaction.
Wordwall	Online interactive activities	Vocabulary practice
ClassDojo	Learning management system and parent communication	Classroom management, parent communication, and classwork.
*Imagine Español	Adaptive application for Spanish language and literacy	Spanish literacy and language development
*Smarty Ants	Adaptive application for English reading foundational skills	Practice basic reading skills (i.e., phonics)
*Dreambox	Adaptive math application	Math skills practice
Boom Cards	Online interactive and gamified activities	Practice for English letter sounds and vowel patterns, and Spanish syllables
Blooket	Online interactive and gamified activities	Practice for English letter sounds and vowel patterns, and Spanish syllables
Kahoot!	Online game-based learning platform	Concepts/skills review or practice
Nearpod	Multimedia creator	Assign independent work for math or social studies. Students can have a choice on how to answer.
*Zoom	Telecommunication software	Virtual field trips, parent conferences

Digital tool	Description	How DL teachers used it
Google Docs	Online document editor	Students present research findings
Google Drawings	Online tool to create diagrams and charts	Students draw responses for science performance assessments
*Scholastic Storyworks	Print and digital magazines aligned to standards. The digital version includes videos, audio, and activities.	Students read the text in English with language supports in the digital version (videos, audio, vocabulary slideshows)
Epic	Online digital library	Students read books in English and Spanish
BrainPOP	Standards-aligned cartoon movies	Introduce a topic, build background knowledge
*This is Language	Online platform with videos and interactive exercises	Students practice listening and speaking in Spanish
Enciclopedia de Ejemplos (ejemplos.co)	Digital encyclopedia in Spanish that includes definitions, examples, and exercises	Learn about a new topic, and provide examples and exercises for students.
Facebook interest-groups	Social media interest groups that facilitate teacher collaboration	Gather materials in Spanish, learn new teaching strategies, collaborate with other teachers
TikTok	Video social media platform	Learn new teaching strategies, collaborate with other teachers
*GoGuardian	An application that monitors students' activity online and filters content	Monitor student activity online

Note. Items marked with an asterisk (*) were purchased by school districts. DL= dual language

VITA

PAOLA GABRIELA MENDIZÁBAL

EDUCATION

PhD Educational Leadership Policy and Planning. Curriculum and Learning Design.
WILLIAM & MARY, Williamsburg, VA • 2020-2024

Master of Arts in English Language Learner Education
WESTERN GOVERNORS UNIVERSITY, Salt Lake City, UT • 2018-2019

Bachelor of Arts in Interdisciplinary Studies K -8, Teacher Preparation Program
WESTERN GOVERNORS UNIVERSITY, Salt Lake City, UT • 2009- 2012

Associate of Arts in Business Management
BOROUGH OF MANHATTAN COMMUNITY COLLEGE, New York, NY • 2005-2006
Graduated with honors.

PROFESSIONAL EXPERIENCE

2022- Current. ***Dual Language Instructional Specialist***. Newport News Public Schools.

- Provide instructional support and professional development to 28 dual language teachers at 2 early childhood centers, 2 elementary schools, one middle school, and one high school in Spanish and English.
- Collaborate with teachers in the development of curricula and assessments aligned with Spanish language arts standards.

2020- 2022. ***Research Assistant.*** School of Education-College of William & Mary.
P.I., Dr. Katherine Barko-Alva

2013- 2021. ***ESL Teacher***, ***Dual Language Lead Teacher, Elementary Teacher***. Newport News Public Schools.

- Supported students' language development and academic achievement through culturally responsive practices.
- Created a Spanish immersion classroom environment that ensured every student's academic and personal growth.
- Developed Spanish language arts curriculum for K-5, and adapted math and science curriculum to be taught in Spanish.

TEACHING

Fall 2022 CRIN523: Bilingual Education & Dual Language Programs. William & Mary. Co-teaching with Dr. Barko-Alva.