2019

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Heliyon 5 (2019) e02575

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.heliyon.com

Heliyon

Research article

A first-year middle school science teacher's experiences navigating science content in a Dual Language Immersion Program

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ARTICLE INFO

Keywords:
Dual language instruction
Middle school
Science education
Education

ABSTRACT

Dual Language Immersion Programs (DLIPs) are offered as a way to address the needs of the students in our classrooms with a primary language other than English and a way to promote multilingualism for both English learners and native-English speakers. This study examined a first-year middle school science teacher's experience teaching in a DLIP. The authors focused on the teacher's challenges and how he handled the tensions between teaching science content and addressing issues of language development in a DLIP classroom environment. Based on classroom observations, pre- and post-year interviews, and weekly teacher reflections, themes emerged that reveal the teacher's concern with teaching science in Spanish, the need for support from both administration and science content and DLIP mentors, students' willingness to use Spanish, and the teacher's lack of familiarity with DLIP curriculum and pedagogy, particularly in regard to balancing the teaching of content and language. This study provides implications for both teacher preparation programs and for DLIP school administrators.

1. Introduction

Public K-12 classrooms in the United States serve an increasingly diverse student population. Close to ten percent of public school enrollments include students with a home language other than English (National Center for Education Statistics, 2017). According to 2013 U.S. census data, Spanish is spoken by about 71% of Emerging Bilinguals (EBs), followed by Chinese at four percent, Vietnamese at three percent, and French/Creole at two percent (National Center for Education Statistics, 2017). Growth in the numbers of EBs varies across states, as well as the concentration of specific languages. According to the National Center for Education Statistics (2017), California has the highest enrollment of EBs at 24% of the total U.S. K-12 school enrollment; Nevada and New Mexico follow with 17%, Texas at 15%, and Colorado at 13%. Interestingly, Somali and Arabic are Maine's top languages other than English, while Napali ranks highest after English in Vermont. Historically, the U.S. population has been positively regarded as linguistically diverse, thus it is critical that U.S. schools strive to maintain EBs' home languages.

Schools attempt to meet the English language needs of EBs with various types of programs. Some schools integrate an English as a Second Language (ESL) curriculum into general education classes (e.g., math, science, social sciences, etc.), while others use a pull-out model in which EBs are taught ESL as a separate class. Some schools have a "walk to English" period of the day when all students receive English language instruction. Despite a myriad of program models, research demonstrates that benefits of learning a language through academic topics are numerous (Brown, 2004; Crandall and Tucker, 1990; Genesee and Lindholm-Leary, 2013; Met, 1991) making language learning more concrete rather than abstract (Genesee, 1994), broadening and deepening language proficiency (Crandall and Tucker, 1990), and promoting critical thinking skills (Met, 1991). Students learning in a second language must not only learn language through the curriculum, but also must master content. The academic demands of each subject area increase, and concepts become more abstract and cognitively demanding each year for students. One of the obstacles to academic achievement for EBs lies in the lack of second language acquisition training among mainstream teachers (Arkoudis, 2003; Freeman et al., 2016; Peregoy and

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https://doi.org/10.1016/j.heliyon.2019.e02575
Received 11 March 2019; Received in revised form 3 June 2019; Accepted 30 September 2019

Boyle, 2017).

The complex pedagogy required to ensure the academic success of EBs is reflected in the TESOL standards for ESL teacher preparation programs (TESOL International Association, 2010). These standards encompass a variety of domains that include knowledge of: English linguistics, second language acquisition theories, culture as it affects learning, planning and implementing standards-based ESL instruction, using resources and technology effectively, ESL history, advocacy and professional development, and different types of assessments and issues surrounding assessment of EBs. Although the standards specifically target the preparation of ESL teachers, they have implications for mainstream teachers.

A growing alternate approach to working with EBs is a Dual Language Immersion Program (DLIP) (Maxwell, 2012a,b). What makes a DLIP classroom unique is that it is comprised of both native and non-native speakers of English, ideally 50 percent from each group, respectively. At least 50 percent of instruction must be taught in the non-English language in order to be considered immersion (Fortune and Tedick, 2008). These programs normally begin in kindergarten and continue through elementary school. Given what is known about the length of time it takes to become an advanced level speaker of another language, DLIPs ideally continue through middle and high school. Different DLIP models exist. In the 90/10 model, 90 percent of instruction is taught in the non-English language beginning in kindergarten through second grade. English instruction subsequently increases by ten percent throughout remaining elementary grades until 50 percent is reached, normally at the fourth or fifth grades (Calderon and Minaya-Rowe, 2003). Other variations include 80/20 and 50/50.

A plethora of empirical studies has provided substantial evidence that students, both native-English speakers and EBs, who participate in high-quality DLIPs over an extended period of time (usually until at least fourth grade) outperform their peers educated in non-DLIP on standardized and criterion-referenced (particularly in reading and math) and English-language proficiency tests (Lindholm-Leary, 2008, 2013, 2016; Marian et al., 2013; Thomas and Collier, 1997, 2011). In addition, DLIPs are effective for students with special education needs (Lindholm-Leary and Howard, 2008), students with speech-language impairments (Lindholm-Leary, 2008), and students from disadvantaged socioeconomic backgrounds (Thomas and Collier, 2011). Reasons to support why "less English" leads to higher academic achievement for EBs are related to research that shows having a solid foundation in literacy and academic content in one language provides a "transfer" to the second language (Cummins, 1981).

While DLIPs are an effective approach to improving the academic success of EBs, there are challenges. Program quality must be upheld, balancing content and language instruction is very tricky, allotting the appropriate amount of time to spend in the primary (L1) versus the secondary (L2) language needs to be managed, and finding resources can be time consuming and at times practically impossible, depending on the language (Cammarata and Tedick, 2012; deJong and Bearse, 2012; Howard et al., 2007; Potowski, 2004; Tedick et al., 2014). Another pressing concern is the lack of DLIPs at the secondary level and a corresponding dearth of research on them to inform instructional and program quality (deJong and Bearse, 2012). Additionally, the United States does not have national DLI teacher preparation standards, even though there is a consensus in the field that effective DL teaching demands a very specialized pedagogy (Lachance, 2017). Outside the United States, research has been conducted on a variety of second language models using the Content and Language Integrated Learning (CLIL) pedagogy (Dalton-Puffer et al., 2010; Perez-Canado, 2012; Smala, 2013). Although CLIL and DLI are not synonymous, Perez-Canado (2012) noted that while CLIL is being widely implemented across Europe, its impact is not well documented. Even on a global level, then, little research exists on how to best prepare high school science teachers to teach in this type of environment.

2. Background

Traditionally, language immersion programs prioritize the teaching of content, with little explicit attention to the teaching of the language per se. According to Cammarata and Tedick (2012), "Since the 1970s, studies have shown that while immersion students acquire native-like receptive skills, their productive skills remain lacking" (p. 253). Research has revealed that immersion students' grammatical accuracy and variety of vocabulary use are typically lacking, even after several years of participation in an immersion program (Fortune, 2012). As a result, a renewed emphasis exists on the balancing of teaching content and language in an immersion program. Kong (2009) analyzed science lessons of four middle school English immersion teachers in China where the focus was on content-based instruction. She found that the most successful type of pedagogy involved the teacher and students exploring content in-depth, with many opportunities for students to revisit the content, an explicit focus on the use of specific grammar forms that provides students ways to talk about the content, and opportunities for student interaction using the content. Kong concluded that language immersion teachers need a strong understanding of the roles of grammar and language functions (such as cause and effect, asking questions, and hypothesizing) specific to a particular content area, like science.

Cammarata and Tedick (2012) conducted a phenomenological study involving the "lived experiences" of three immersion teachers who had just completed a year-long professional development program focused on balancing the teaching of content and language. Teachers represented grades four, seven/eight, and high school (science). Data collection included teacher interviews and journal-type entries written by the teachers. The aim of the study was to gain an understanding of the teachers' specific experiences and reflections regarding the teaching of content and language. Their analysis revealed the teachers found they were transforming from viewing themselves as teachers of content to teachers of content and language. Second, the teachers faced many challenges that were out of their control; such as, lack of planning time, lack of resources, lack of being held accountable for developing students' language proficiency, and administrative expectations for meeting standards. Third, teachers felt "isolated" from colleagues. Fourth, teachers became more aware of the importance of language for learning content, particularly at the secondary level. Teachers struggled knowing which language to emphasize and how to integrate it into the teaching of content. The researchers emphasized that immersion teacher preparation and on-going professional development (PD) are critical for immersion students to develop bilingualism and achieve academically.

Cammarata and Haley (2018) implemented a longitudinal case study in Canada with 15 French immersion teachers (grades 6–12) with varying years of experience. Researchers collected data while teachers participated in a year and a half long PD project targeting the balancing of teaching content and language. Researchers found that teachers struggled with deciding what aspects of language and literacy they should emphasize while teaching content. Teachers tended to equate language with vocabulary, neglecting the importance of grammar and syntax. The most important finding was related to the pedagogical changes the teachers needed to make while balancing the teaching of content and language. These changes included pacing, time constraints, and task complexity, which resulted in teachers changing their usual teaching routines. The researchers highlighted the value of on-going collaboration that teachers experienced during the PD, along with the opportunity to apply what they were learning in the classroom. Teachers reported that learning how to balance language and content was facilitated by post-lesson discussions during which they were given time to provide feedback to each other.

3. Methods

The purpose of this study was to determine how a novice teacher with no DLI training managed teaching middle school science in a DLIP. The

researchers, a first-year teacher and two university professors, sought to identify challenges and successes of the novice teacher's experiences to inform both teacher preparation and DLIP development at the secondary level. The research questions addressed were:

a) How does a first-year science teacher in a middle school DLIP navigate the planning and the teaching of science content and the Spanish language?
b) What challenges does a first-year middle school science teacher face as a DLIP instructor?

This study serves to contribute to two important gaps in the research on DLIPs. First, there is a scarcity of research on secondary DLIPs (deJong and Bearse, 2012), especially in the context of science; and, second, a focus on a beginning DLI teacher without DLI training may highlight specific areas in need of attention in preservice teacher preparation programs.

Qualitative research methodology was appropriate for this study because the primary focus was on developing an understanding about how a novice middle school teacher managed the teaching of science in a DLIP with little language teaching training. Fostering, documenting, and reporting on emic perspectives are characteristics of qualitative methodology that in turn drives data analysis (Creswell, 1994; Stake and Mabry, 1995).

From an epistemological stance, qualitative research involves researchers interacting closely with participants. This study involved one teacher participant and two researchers: a first year DLI middle school science teacher (Erik) (the subject of the study) and two university professors as the researchers (one science teacher educator, Patricia, and one bilingual education specialist, Sally). This study was framed as a case study (Merriam, 2009) in naturalistic inquiry (Lincoln and Guba, 1985). The case was bounded by focusing on one teacher in his classroom during his first year of teaching.

The researchers used the Guiding Principles for Dual Language Education (GP) (Howard et al., 2018) as the conceptual framework for data collection and analysis. This document was compiled by bilingual education researchers and provides a tool for planning and implementing effective DLIPs. The document GP is organized into seven strands: program structure, curriculum, instruction, assessment and accountability, staff quality and PD, family and community, and support and resources. Each strand is supported by a concise and current literature review of the research and provides guidance for implementation. The researchers for this study specifically used four strands; namely, the staff quality and PD, support and resources, instruction, and curriculum strands as a lens for data analysis as these are the strands that most closely relate to the focus of this study.

Erik (the first-year teacher) has a BS in biology and had just completed a Master in Arts of Teaching (MAT) in Secondary Education, earning his teaching license and a secondary biology endorsement. Prior to teaching, Erik had varied experiences that served him well in the classroom. He had a strong biology background having worked as a lab technician. He had honed his Spanish language communication skills by interacting with a Latino population while working for a political party. However, Erik's only prior teaching experience was gained through his student teaching experiences. He had spent 15 hours per week for 16 weeks in a middle school biology placement, and full days for 16 weeks in a high school biology placement. While as an MAT student he did have a class on literacy across the curriculum and some introduction to Sheltered Instruction Observation Protocol (SIOP) principles integrated into his coursework, his only experience with DLI was attending a K-5 language immersion school as a student in grades K through 2 and having a mother who was a Spanish immersion teacher. He had four years of high school Spanish, received SIOP training the summer prior to teaching, and completed one ESL endorsement course in the fall of his first year of teaching. In the summer leading up to his teaching placement, he received eight hours of PD from the DLI elementary teacher in the district that included DLI strategies and time to examine curricula topics for the year (e.g., what unit topics aligned with specific grammatical structures and academic vocabulary [cognates, reflexives, tenses, etc.]). Erik is the focus of this case study.

The two researchers on the project are Patricia and Sally. Patricia, the science teacher educator, had two decades of experience teaching science methods and ten years of experience as a 6–12 math/biology teacher. She is a native- English speaker with an elementary level of Spanish. Erik had been enrolled in her secondary science methods class. Patricia supervised Erik's student teaching placements in both the middle and high schools. They had developed a positive, supportive relationship through those experiences. They saw Erik's first professional position as a good opportunity to add to the research base on science teaching in DLIPs.

Sally, the bilingual education specialist, has a background that includes teaching high school French for eight years, with endorsements as a Reading Specialist and in ESL. She currently prepares both preservice and in-service teachers to work in a variety of bilingual education programs, including DLI. Sally is fluent in English and French and has a basic knowledge of Spanish. Patricia and Sally worked at the same university. Sally was asked to join the research team because of her expertise in SLI. She had no interactions with Erik prior to this research study.

The middle school that served as the context for this study is located in a district in the Pacific Northwest that has a diverse student population. At the time of the study, the district served 5000 students in two K-6 schools, one K-8 school, one middle school (the study school) with grades 7–8, and one high school (9–12). In the middle school, the student population of 605 students was predominantly White (62%) and Latino (31%). Forty-four percent of the students were on free or reduced lunch. Six different languages were spoken in the students' homes, and 27% of the student population was identified as an ELL. Sixty percent of the students met the state proficiency level in science, 50% in English/Language Arts, and 42% in mathematics.

The district had one K-6 school offering a DLIP since 2004. The district was trying to meet parental pressure to continue the DLIP into the secondary schools and eventually graduate high school students with a Seal of Biliteracy on their diplomas. The Seal of Biliteracy is an award given by some schools to students who have studied and attained proficiency in two or more languages (https://sealofbiliteracy.org/). Because this particular middle school had a social studies teacher who was fluent in Spanish, the school began offering DLI in social studies in 2011 (when the kindergarten class would have reached seventh grade). Erik was hired with the intent of expanding the DLIP to two classes by adding Science to be taught in Spanish. It is important to note that there was no DLI program coordinator in the district at the time of this study, and the previous administration in the middle school had not bought into moving DLI to the middle school.

Students involved in the DLIP participated in an 80/20 DLI model in the K-6 feeder school. Erik taught five classes of 8th grade Integrated Science: three in the DLIP and two in English. There were approximately 30 students in each class. The reading level of the students in his classes in both native languages was varied and ranged from second grade to high school. In the DLI class, about two-thirds of the students were native-Spanish speakers. Erik tended to speak mostly Spanish in the DLI classes, and averaged about 90% Spanish and 10% English (in his own estimation). In one Spanish class there was a full-time native-Spanish speaker who assisted students as needed and could provide on the spot translation if needed. Erik planned in English and then translated content into Spanish for his DLI classes. When he had trouble with translations, he would use Google Translate © and Spanish language textbooks. His reliance on these tools lessened as the year progressed. Because of the limited availability of DLI courses, the eighth-grade DLI science course enrolled both seventh and eighth graders.

A variety of data sources was used for this study. A three-way conversational interview was held at the start and end of the academic year. Each conversation lasted about an hour and questions focused on Erik's experiences and challenges involving planning and instruction.

Patricia and Sally took notes during the interviews then met immediately afterward to discuss insights. Interview notes were word-processed and shared among the three participants for member checking. Additionally, Erik kept weekly journal reflections wherein he reviewed his thoughts about how classes were going, any concerns that arose, and any "a-ha" moments, and recorded them. He shared his journals at the end of the year with Patricia and Sally. During the school year, Patricia and Sally each made two visits to Erik's classroom to observe a set of classes (the same lesson taught to the English class and the DLI class). During visits, researchers took running record observational notes and completed an "Immersion Teaching Strategies Observation Checklist" (Fortune, 2000) to focus on the areas noted in the GP. Each observation was followed by a post-observation session with Erik to prompt reflection on the lesson planning and delivery and to jointly review the checklist. Patricia and Sally kept records of post-observation notes.

Patricia and Sally read through pre-interview notes, eight sets of classroom observations, the checklists, debriefing notes, and journal reflections separately, prior to the post-year interview with Erik. They then reviewed all data sources following a six-step coding procedure as described by Auerbach and Silverstein (2003). Patricia and Sally, individually, analyzed each data set by selecting "relevant text," rereading the relevant text for "repeating ideas," grouping these into categories, and connecting these to the GP. Patricia and Sally compared their notes and analyses. There was basic agreement on the themes, and discussion centered on ways to further condense the themes and "name" them so that the final set of themes would succinctly retell Erik's story. Themes were then presented to Erik for member checking to validate.

The study's ethical approval was granted by the Institutional Review Board of the University of Portland, Portland, Oregon.

4. Results and discussion

The five main themes that emerged from data analysis involved Erik's facility with L2, lack of mentorship/professional learning community, a need for DLI science curriculum, content/language interplay, and a focus on students. We utilized Erik's words as titles for these themes, as they provide more of a vicarious experience for the reader, and as Auerbach and Silverstein (2003) suggested, "The research participants should be able to recognize the themes as something they might have said" (p. 65).

4.1. Using Spanish was an uphill struggle (facility with L2)

Erik realized at the beginning of the school year that teaching in a DLIP was going to be tough. Initially, Erik was very concerned that his Spanish language skills were "rusty." He feared his students would not learn from him because of his lack of confidence with the L2 and was also concerned that his students' parents (both Spanish and native-English speakers) would be concerned with his capabilities of teaching in Spanish. He wrote the following in his journal:

> When I think back to my very first prep period on my very first day of classes, there was a lot of despair swirling around inside my head. I had bitten off more than I could chew. I couldn't do it. My Spanish was in no way up to snuff for what I needed to do. (Journal Reflection, September 28)

A few weeks into the school year, Erik continued to be concerned about his Spanish language skills but was beginning to feel more confident, as reflected in this journal entry:

> While my Spanish is still an uphill struggle, my confidence in the language has been growing. Everything I knew has definitely flooded back and now I am even advancing beyond where I was (hopefully). (Journal Reflection, October 2)

Erik found that he could plan for the Spanish he would need for his teaching, but that he felt unprepared for spontaneous communication with his students. He wrote in his journal:

> This week, I had a moment that perfectly summed up some of my biggest struggles as a DLI teacher. I mentioned last week my struggles with Spanish. I don't mean to imply that I am a Spanish 101 student, but it has been over a decade since I used my Spanish on a day to day basis and it is definitely rusty. For content specific vocabulary, I can use a dictionary or google to prepare for my lessons, however it is the interactions that are unplanned, like student redirections where I sometimes draw a blank. (Journal Reflection, Week of October 9)

The following journal reflection shows Erik's nervousness when it came time for parent conferences. He wrote:

> I have been dreading parent teacher conferences for a couple of weeks now. My biggest fear was that I would be exposed as a fraud with the Spanish-speaking families who feel my Spanish is not good enough or who feel like they are talking to an imbecile. I spent a decent amount of time before the first day of conferences writing down and practicing phrases I could use when discussing my class with parents in Spanish. (Journal Reflection, Week of October 16)

However, Erik gained more confidence as the year progressed, as there were signs appearing to him that his Spanish skills were strong enough to teach science. He wrote:

> My students, both Anglo and native Spanish-speakers, continually come to me with questions about Spanish vocabulary and grammar. If they truly felt I did not speak Spanish well they would surely go to another source. Every time a student asks me for help with Spanish writing, I get a little ego boost. (Journal Reflection, April 1).

By the end of the year, Erik was less worried about his Spanish and claimed, "I caught myself speaking Spanish in my English classes" (Post Observation Discussion, May 18).

Although it appeared that Erik was eventually able to handle the level of Spanish language proficiency required to teach science at the middle school level, it was a constant worry for him. According to the GP (Howard et al., 2018), DLIP teachers should have near native language proficiency so they can provide "cognitively stimulating instruction" (p. 91). Erik spent extra time lesson planning to ensure he was using accurate vocabulary and grammar structures while teaching. First-year teachers have many learning curves, but first-year DLI teachers have the added burden of planning for the language they will use during instruction, in addition to the language of the content itself.

The GP (Howard et al., 2018) recommend that administrators carefully consider applicants' language proficiency during the hiring process. It is documented that finding DLI teachers at the middle and high school levels is difficult (Kennedy, 2013), because of the high level of language proficiency it takes to teach content. It is not surprising that districts might compromise the credentials of staff they employ.

4.2. I am alone on an island (lack of mentorship/professional learning community)

Aside from being a first-year teacher in the school, Erik felt a deeper sense of isolation than most beginning teachers as he was the only DLI science teacher (the only other DLI teacher in the school taught Social Studies). Erik did not have a mentor in the building (in either DLI or science) and did not feel part of a professional learning community. The Social Studies DLI teacher was located in a different part of the school, and they did not share a common preparation period. Further, Erik preferred to teach science differently than his science teacher colleague. He told us, "The other science teacher does more teacher-centered learning. I prefer activity-based learning," (Early Interview, October 10).

Although Erik was gaining confidence in his Spanish language skills, he quickly realized that he was not sure how to teach science through Spanish.

> While my Spanish language abilities improve and allow me to offer more instruction in Spanish, I find there are many other facets of a dual language program that I am struggling with as a core content teacher. None of my standards involve Spanish language proficiency. How much of my class should be in English and how much should be in Spanish? How much emphasis should I be placing on Spanish grammar? Should I be focusing more on language development or is this just a science class that happens to be in Spanish? (Journal Reflection, October 2)

Adding to Erik's frustration was that the building administration observed Erik teaching only in science classes that he taught in English, as they were not fluent Spanish speakers. Erik received no feedback on his DLI instruction. This sense of isolation remained throughout the year and he continued to wonder how he should teach science and Spanish together. He wrote,

> By not having my DLI classes observed, it does make me feel a little more like I am alone on an island. The only other teacher who teaches DLI is the Social Studies teacher, but I almost never see her. During staff meetings there is not a lot of time to talk, we do not share a lunchtime or a prep, and after school I usually have students in my classroom so I can't go looking for her. Since my last experience with an immersion classroom was in 2nd grade, I really feel like I need validation that what I am doing is okay. I know the science part is fine, but I would like to know what I should be doing in terms of language besides just teaching in Spanish. (Journal Reflection, November 6)

With little training in DLI pedagogy, Erik struggled to find a balance between teaching science and Spanish language skills. He wrote:

> I keep getting mixed messages regarding how much time I should be spending teaching content versus language. I believe I am doing fine, but I need someone I can collaborate with and bounce ideas off of. Someone who can make recommendations on ways to incorporate language lessons while still teaching content and someone who understands the issues with immersion education. (Journal Reflection, November 6)

According to the GP (Howard et al., 2018), an exemplary DLIP provides on-going opportunities for in-district staff collaboration or networking with staff working in other DLIPs. Effective DLIPs are where "sharing of best practices is the norm" (p.104), particularly when time is allowed for exchanging ideas and curriculum development. In addition, the GP recommend that DL staff be evaluated by administrators who have "deep knowledge" (2018, p. 99) about DL education and who use evaluation tools specific to DLIPs. Erik was operating alone with little knowledge about how DL education should be implemented. If time had been built into their teaching schedules for collaboration, both DLI teachers would have benefitted from it. If an administrator had observed Erik teaching one of his DL classes, his struggles would have been noted and could have been addressed, ideally through professional development targeting DLI. This lack of attention to DLI on the part of the school administrators is evidence of the need for a district-wide implementation plan and appropriate staff to oversee the DLIP.

4.3. Trimming the fat? (need for a DLI science curriculum)

Erik was faced with familiarizing himself with a curriculum new to him while having a lack of academic resources in Spanish. Erik was given learning targets and standards to be met in science, but no curriculum framework. He was given textbooks that had both Spanish and English versions, but he did not rely heavily on the text for his instruction. He preferred to use current materials and handouts, many of which he created himself or downloaded from the Internet and translated into Spanish. He expressed his frustration in his journal, "Where to find Spanish language science materials that are free to me would be an incredible help" (Journal Reflection, February 19).

Erik's pedagogy focused on active learning, such as inquiry, hands-on application, and use of models, which is recommended for DLI instruction (Hamayan et al., 2013). Erik explained:

> Many of my students that struggle with academic language have been excelling, because when they are working with their hands and solving through trial and error, they are eliminating the language piece and allowing their thinking to shine through with their actions instead of trying to put their thoughts into words which is more difficult for some students. (Journal Reflection, November 4)

Erik was faced with a sense of uncertainty about how much language instruction he should teach and was concerned about reducing the amount of time to teach science content. Teaching the curriculum for the first time, and being a first-year teacher, did not provide him with any previous experience to guide his decision-making. Erik tended to keep the scale tipping more toward the science, than the language side. He did feel he was learning as he went and believed his second year in the program would be much improved. He wrote:

> I have been told I can trim the fat off my curriculum. Unfortunately, I have no idea what should be cut and what requires more emphasis, because I have never taught this before and I am building my curriculum as I go. (Journal Reflection, September 28)

Erik spent hours in lesson preparation. He claimed, "The vast majority of the time I spend lesson planning is translating the lesson, slideshow, or the test I just made into Spanish. It is very time consuming" (Journal Reflection, November 13). Although the school supplied adequate science materials in English, Erik had to create his own Spanish materials. With no science curriculum in place, and along with that, no alignment between science content and appropriate language structures and vocabulary, Erik was teaching on the fly. The time he spent translating his instructional materials into Spanish could have been dedicated to creating a scope and sequence or curriculum map that would have helped guide his teaching. Strong DLIPs provide sufficient resources in both languages and a scope and sequence for standards-based language and literacy development (Howard et al., 2018).

4.4. Specific science language issues (content/language interplay)

While somewhat overlapping with other issues, Erik did not feel he had a teacher's "tool box" of ways to integrate science and language. He did not have a reference list of cognates, for example, and felt teaching academic language in the L2 was difficult. Erik opined that teaching cognates with science terms was not always helpful. He claimed:

> In social studies and language arts, if they are learning terms in Spanish, they may have an English word to fall back on and compare to. In science, with brand new vocabulary, they don't have this, no matter what the language is. Students don't always know English versions of cognates because they didn't know the word before; for example, *momento* doesn't mean momentum. (Post Interview, September 9)

However, he recognized the importance of teaching cognates, as evidenced in this statement: "Cognates make things easier, for example, physica and physics" (Post Interview, September 9). Students did not have any previous experience with science concepts, and mnemonic tricks he knew in English did not transfer into Spanish. He believed that teaching language was not always congruent with good science teaching. For example, the SIOP teaching framework recommends the front-loading of vocabulary (Echevarria et al., 2017), while in the science methods course Erik was taught to teach vocabulary after hands-on experience/context, and not beforehand. Erik told us that he "Didn't front load the vocabulary but waited until it was used in context. That made more sense" (Post Interview, September 9). In a study by Settlage et al. (2005) novice elementary teachers who were learning to implement

inquiry science found that this SIOP technique ran counter to inquiry teaching. These teachers noted they originally "struggled" with withholding explicit objectives and vocabulary and the "misalignment between SIOP… and science inductive approach" (p. 51). Erik may have had less of a conflict because inquiry instruction was not as new to him as using SIOP principles.

For students learning content in bilingual programs, metalinguistic awareness and skills need to be explicitly taught (Howard et al., 2018). This involves the teacher and students working together to analyze similarities and differences between the two languages such as vocabulary, grammar, and the writing and sound systems. Erik's comments about cognates shows that he knew this was important, but he struggled with how to teach new words for which the students had no background. There are strategies for teaching new vocabulary in another language (Smith-Walters et al., 2016), and if Erik had more training in second language teaching he would have had more of an instructional "tool box."

4.5. Student push-back (focus on students)

Erik had a strong sense of obligation to student learning. Partly due to his desire to be viewed as a professional (his concern with his language facility) and partly due to his desire to build a comfortable classroom community, he felt it was important to develop mutual respect with and among his students. He was concerned with his students as learners. Erik reported that students were reluctant to speak Spanish during class. Erik wrote:

> In my 4th period DLI class, several students will respond to questions in English and because they are so reluctant to participate and answer questions I will sometimes tolerate it just so we can keep moving. This week I finally put my foot down and would not accept an answer unless it was in Spanish. (Journal Reflection, March 11)

Erik observed that females were more reluctant to speak in Spanish than males. He attributed this to the females feeling more self-aware, more peer pressure, and more judgment. Erik claimed that males would speak in English as well, but would switch to Spanish when he requested. Erik wrote in this journal near the end of the year that:

> The girls have given me more push-back all year. Case in point is a group of three girls in my 5th period that almost always address me in English. When I refuse to answer, they repeat louder. When I ask them to repeat in Spanish, they sigh and either try to avoid it or use as few words as possible or say, 'I don't know how to say it in Spanish.' Battling entitlement is an ongoing issue and it is not limited to the Anglo girls (Journal Reflection, April 8)

Indeed, the native Spanish-speakers were reluctant to use Spanish as well, and further, Erik observed that their Spanish skills were not strong. Erik reflected in his journal:

> The native Spanish-speakers prefer to use English and their English is strong, and their parents encourage the use of English. Their academic Spanish is weak and they struggle with accents, reflexive verbs and complex verb tenses, more so in writing. The native English-speakers struggle with future tense. They need a Spanish Language Arts class! (Post-Observation Conversation, May 18)

Although the use of English has a role in the DLI classroom where the target language is expected to be used, learners need to have multiple opportunities to use the target language and be pushed to do so (Howard et al., 2018). Research in DLI classrooms has revealed that learners tend to resort to English, especially during peer to peer interactions (Potowski, 2004). It has been shown that second language oral skills boost students' reading skills (August and Shanahan, 2006) and lead to deeper processing of the language (Van Lier, 1988), so having conversations with students about the importance of speaking in L2 may help mitigate student "push-back."

Erik did find that his students were patient and understanding with his first-year teaching challenges. He acknowledged this in his journal writing:

> My students are incredibly supportive of me as their teacher. I am grateful that my classroom has developed a culture where they can tell me, you should use this word instead of that, without there being any malice or sneering involved. (Journal Reflection, October 23)

While Erik had student teaching experiences working with culturally diverse student populations, working in the DLIP made him realize the array of experiences that EBs bring to the classroom and how these experiences may impact student learning. Erik wrote,

> The social stresses put upon migrant students has become very apparent. Learning how many students are separated from mothers or fathers is alarming. Imagine how rough it must be, especially for a 13 or 14 year old to be separated from Mom and Dad and only get to see them for a short time before heading back to the US (referring to travel during school vacations) It must be inredibly stressful. (Journal Reflection, January 8)

5. Conclusions

Findings from this study build upon other studies that provide evidence of the critical importance for DLI teacher preparation and PD. Erik's primary struggle as a first-year DLI teacher was balancing the teaching and learning of content and language. This mirrors the primary issue facing all DLI teachers (deJong and Bearse, 2012). The middle school DLIP was new, so Erik did not have any guidance in terms of what science content should be less stressed or could be omitted to make room for direct language instruction. He did not know how to integrate the two so that he could teach language through the science content. Erik felt that moving to his second year of instruction, he would have a better idea of how to balance language and content, and be stronger in instructing in both areas. With sustained L2 training, Erik might have begun to view himself as a language teacher as well as a "core content teacher," as the teachers reported in the study by Cammarata and Tedick (2012). Regardless, having a set science curriculum as a guide to follow would have greatly facilitated his curricular decisions and reduced his planning time.

Other content specific findings suggest that not knowing where to find strong L2 content resources was a hindrance to both planning and instruction. Ready access to science materials written in L2 would have enabled the use of such resources to augment instruction. Additionally, the interplay between content and language was a concern. Erik's "teacher tool box" had a number of mnemonic devices to help English speaking students remember science ideas (e.g., King Philip Came Over For Good Spaghetti to remember the order of the classification system), but did not have similar tools for the L2. He noted that a list of cognates would also have been helpful. This lack of a robust "tool box" is something for all science methods insructors to consider.

Erik was successful in building a strong classroom culture in which students had mutual respect for each other and for him. Erik reported, based on classroom assessments, that students in both his English and Spanish sections learned the science content. His philosophy of using activity-based inquiry, visual models, and group work with science content appeared to work well for all his students. Erik was successful in completing his first-year, received positive feedback from the school administration, and although he was invited back to continue his teaching assignment, he accepted position at a high school that does not offer DLI.

In the post-year interview, Erik was asked to provide adjectives to describe his DLI experience. He chose "anxiety" and "isolation." He admitted that he had trouble "teaching language conventions (grammar, tenses, structural components)." Asked to provide adjectives describing

his science teaching experience, Erik chose "invigorating," "exciting," and "empowering." He told us that he, "really enjoyed the ability to tinker and explore and play. I relearned some of the concepts in chemistry and physics and they are much clearer now." (Post Interview, September 9). Erik's choice of adjectives is noteworthy and reveals his lack of knowledge about language teaching and learning. He was clearly prepared to be a "science" teacher, not a "language" teacher.

The limitations of this study include the small sample size of following only one teacher in one particular school's program. Additionally, since this was the first year of this particular science course in this particular school, the context provided additional complications for the teacher. Erik's background was unique for a DLI teacher; a teacher with preparation in both DLI and science may have had a difference experience.

There are many implications arising from this study. For teacher preparation programs, the contrast between Erik's choice of adjectives in describing his DLI experience versus his science teaching is revealing. Erik was prepared to be a "science teacher," and when he was presented with the opportunity to teach science in Spanish, it seemed intriguing to him. Although he had attended a DLIP himself, he dove into the position with no theoretical or practical knowledge about the intricacies of DLI. Given the growth of DLIPs, teacher preparation programs might consider integrating foundational information about bilingual education into the general education curriculum. Even in an intensive or fast-track licensure program, teacher candidates need a course focused on second language acquisition, academic language instructional strategies, and how to make the content accessible to EBs. These skills are important to any teacher given the language diversity found in today's classrooms.

For methods instructors, this study's findings stress the importance for all preservice teachers to realize the importance of teaching academic vocabulary and how to go about doing this. The importance of understanding the nuances of teaching academic language is well documented (e.g., Coyle et al., 2010; Schleppegrell, 2009). Training teachers how to write language objectives, along with their content objectives, is vital in every content area, because it provides teachers the opportunity to analyze the language demands of specific content concepts and skills. According to Chamot and O'Malley (1994), each content area has its own particular language skills, syntax, and way of thinking. This is critical information for teachers and would assist them in creating lessons that develop students' language skills like those used by experts in the "real world," such as scientists, mathematicians, historians, etc. In addition, the teacher's tool box needs to be broadened to include an array of instructional strategies that make content accessible to all students, an understanding of when specific strategies are best implemented and why they are effective, and where to find resources that can help ELLs learn science, as well as cognate lists and other "tricks" such as mnemonic devices.

Other implications are also revealed through this study. For example, reflection is a vital part of preservice teacher preparation programs (Schön, 1987). Erik noted that reflecting through his journal writing helped him develop a list of items to work on in the future (both for science teaching and for DLI). We found that having his journals as a basis for discussion showed that he took the time to examine his teaching "in the moment" and helped him to monitor and adjust throughout the academic year. Thus reflection should continue to be an important aspect of teacher preparation. Additionally, given the lack of qualified secondary teachers to work in DLIPs, teacher preparation providers should consider designing specific programs to prepare candidates to work in DLIPs. Because our general education classrooms include more and more language learners, it would be prudent for teacher preparation to include basic information about second language acquisition, including the amount of time it takes, so that teachers understand and know what language abilities their learners possess according to their level of language proficiency. This would allow teachers to better plan instruction that is differentiated to their students' language abilities and develop empathy for the challenges involved in language learning.

Administrators should note some aspects that would have eased Erik's first year as a DLI science teacher. Erik expressed on several occasions both how he wished he had had more pedagogical preparation in DLI and the time to have practiced his Spanish, especially science terminology. The need for a mentor and other first-year supports were also evident. While many studies have examined the value of teacher induction programs (Luft et al., 2015), this was especially true for Erik. He really wanted someone with whom he could talk regularly, who could offer suggestions and feedback on his instruction and planning, and who could provide support. He especially wanted explicit guidance on the balance of content and language. It would have been helpful for Erik to know where to find age-appropriate reading and video materials in Spanish. While his administrators were willing to purchase materials, Erik was unaware of sources for these materials until the end of the year. It would be beneficial for current DLI teachers to have an on-line repository for sharing materials among themselves.

Many challenges exist for implementing DLIPs at the secondary level, especially because of the differences in structure and organization from elementary schools. Because a number of different programs is normally implemented at the secondary levels, administrators need to be aware of the importance they place on the implementation of a DLIP program in their schools. In this study, the DLIP was well-developed and well-implemented at the primary level, but moving to the secondary level caused some oversights. For example, there did not appear to have been a district-wide DLIP implementation plan, a DLIP program coordinator was in need, no secondary curriculum existed, there was a lack of materials and resources in Spanish, and there was a lack of support and PD for the secondary DLI teachers. Given the amount of time it takes to reach high levels of language proficiency, DLIPs must exist through the middle and high schools if our society wants to produce "advanced" speakers of another language (American Council on the Teaching of Foreign Languages, 2015). The researchers hope that the findings from this study will add to the knowledge base about secondary DLIPs and assist in addressing the inadequacies in secondary DLI teacher preparation and in the structure and support needed at the secondary level.

One last insight that needs to be mentioned in terms of DLIP implementation is that Erik felt having a DLIP identity in the building was an important ingredient for successful program. Erik explained this in his journal:

> Our program does not have an identity. Our students do not feel like they are a part of a DLI program. They do not feel connected to something bigger. I think a big part of that is how we emphasize it in the school. Walking through our halls, you would have no idea that we have a DLI program. (Journal Reflection, May 20)

This is another troubling finding of this study. If the DLIP is not showcased by the school, it sends a message to the students, staff, and parents that it is not valued. Advocacy for a DLIP is the first and foremost action needed to ensure the program's success and sustainability.

Declarations

Author contribution statement

Patricia Morrell, Sally Hood: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Erik Mellgren: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Funding statement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Competing interest statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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